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The Wreck of the British Naval Airship.

We briefly noted, on p. 422 of our issue of Oct. 5, the wreck on Sept. 24 of the great rigid dirigible balloon built for the British Navy by Vickers Sons & Maxim. The accompanying cut, reproduced from London "Engineering," shows a view of the great airship just after it had broken in two. The descriptions of the disaster given in our English engineering contemporaries give little information as to its cause, which is not surprising, since military and naval matters abroad are closely guarded from the public.

The brief account of the affair given in "Engineering" is apparently designed to whitewash the occurrence. We quote as follows:

It would be a mistake to attach much importance to the accident on Sunday to the naval airship. The airship is still, like the aeroplane, in an experimental stage, and that built for the Admiralty, although its design has been evolved at the Admiralty and War Office, with the assistance of the Government Aeronautical Research Committee, must be regarded as a great practical experiment, in which the results of trial and error, when carefully analyzed, must yield important lessons.

It may be that too much has been sought for in the matter of carrying capacity, in the praiseworthy aim of excelling in power of attack anything yet achieved by any navy; but that is only in consonance with British military and naval history. We must lead, and to do so we must risk much.

On Sunday the atmospheric conditions suggested a trial flight, and the vessel, in the sole charge of the navy officers, was being taken out of its shed when the accident happened. The material used for the outer envelope proved of high resisting quality, only yielding where there was abnormal tension. The duralumin, of which the girder work is built up, proved very ductile and of great tensile strength against the racking stresses set up.

The material of which the balloonets are made, as supplied through the War Department, has all along been a source of uncertainty and of little accidents, and the facts point to the cause of the collapse on Sunday being due to the rupture of a gas-bag when the vessel was being drawn out of the shed. The adjacent wires which form the braces between the horizontal and circumferential girders broke, owing to over-strain and lack of support, and the girders next to the ruptured balloonet collapsed. The damage was local. Those responsible for the work, and particularly Captain Sueter and Messrs. Vickers, Limited, are to be sympathized with in this set-back to a splendid piece of experimental engineering work; but it is satisfactory to reflect that neither they nor the Admiralty and War Office will be daunted by the untoward event. As with all developments in mechanical science, misfortune is only regarded as temporary, and is but an incentive to further effort.

These views are in striking contrast to those expressed by that vigorous journal "The Engineer." While "Engineering" mildly refers to "the accident" to the naval airship, "The Engineer" plumply terms it "a wreck," and declares unequivocally that the dirigible balloon idea is a mechanical and military absurdity and that it is a pure waste of time and money for England to attempt to follow Germany's lead, when the numerous accidents in Germany have shown the fragility and unreliability of these huge balloons. We quote the following paragraphs from "The Engineer:"

THE WRECK OF THE BRITISH NAVAL AIRSHIP ON SEPT. 24.

It is proverbial that the official mind is hard to convince. For this reason, and this alone, we greatly regret that the naval airship was wrecked at Barrow on Sunday morning, Sept. 24. We believe that had this vessel survived a few months longer even the Admiralty officials responsible for her inception would have become convinced that the airship in general is a hopelessly impracticable affair. As it is, the disaster which has befallen the Barrow airship will probably be attributed to some minor defect.

The vessel will in all likelihood be repaired; indeed, even already there is news to this effect. The £70,000 already expended on her construction will become £100,000. She will once more be "launched," taken back to her shed, variously altered and tinkered with, and almost certainly again become a wreck. It would therefore have been infinitely more satisfactory if the naval airship had survived sufficiently long to prove by her wearisome inactivity and her general inability to fly as prescribed, that, either for peaceful or warlike purposes, failure must be her portion.

The vessel was "launched" on May 22, that is to say, she was undocked from the shed in which she had been built and towed behind a specially constructed wind screen. Here she lay for a short time, after which she was taken back to her shed. From then until Sept. 22 she presumably underwent a process of adjustment and alteration until she was ready to be handed over by her builders, Vickers Limited, to the Admiralty. On the above named day she was formally accepted, on the conclusion of her stability and buoyancy trials, by Captain Sueter, inspecting captain of airships.

On Sunday the weather was adjudged favorable, and under the charge of a party of sailors from H. M. S. "Hermione" a start was made to tow her stern first from the shed. When scarcely clear of it the airship began to heel over to one side. Righting herself on the release of certain guide ropes used in the undocking operations she developed a bulge in the center of a gas bag. Her after end sank into the water, and the forward end began to rise. Accompanied by a tearing and cracking sound the bulge in the gas bag now grew suddenly larger. It became evident that the framework had given way, and that the halves of the vessel were held together simply by the strength of the balloon fabric. The after gondola began to sink, and the men in the boats attached to it were compelled to take to the water and swim ashore. Probably due to this release of weight the stern portion now rose, and the bow portion began to dip into the water [as shown in the cut which we reproduce herewith.—Ed. Eng. News.]

With great difficulty the vessel was hauled back to her shed, where it is to be presumed she will be subjected to examination and repairs. No satisfactory explanation of the accident is at present available. It is believed, however, in some quarters that one of the seventeen balloonets disposed within the body of the vessel had been ruptured, thus removing the local support to the framework.

In our opinion, and in that of many others watching the progress of aerial navigation, this disaster serves only to confirm previously expressed views. We may, if we choose, localize the fault, but fundamentally the accident is due to the unwieldy nature and inherent imperfections of the dirigible balloon.

Steamers and Fueling Barges Equipped with Conveying Apparatus for Discharging Cargo.

The equipment of steamers with conveying apparatus for the discharge of bulk cargo is an interesting development of the varied application of conveying machinery; rapidity of unloading and consequent minimum loss of time in port are the special purposes of this equipment. In our issue of Jan. 19, 1905, we described a plant of this kind on a lake steamer carrying crushed stone, and in our issue of May 25, 1911, we made brief note of an English ore-carrying steamer having a somewhat similar plant. In the present article we describe a more extensive use of this system on the Great Lakes, including two steamers in freight service and a steam barge for delivering bunker coal to steamers. The equipment for all three vessels was designed by the Stephens-Adamson Mfg. Co., of Aurora, Ill., and we are indebted to that company for plans and information.

Cargo Steamers with Unloading Conveyors.

Two lake steamers of the Michigan Alkali Co., of Wyandotte, Mich., have been equipped with unloading conveyors for discharging cargo; these boats carry broken stone from Alpena to Wyandotte, and coal from Sandusky to the company's plant at Alpena, Mich. The first of these was the "Wyandotte," which has a cargo capacity of about 3,300 tons, and whose unloading machinery has a capacity for discharging about 600 tons per hour. This was followed by the "Alpena," which has a cargo capacity of 5,700 tons, and can unload this at the rate of 900 tons per hour. The cargo capacity given is approximate only. The "Wyandotte" has 24 hoppers in two rows with a capacity of 2,736 cu. ft., and the "Alpena" has 36 hoppers of 3,120 cu. ft. capacity. Estimating the weight of crushed limestone at 100 lbs. per cu. ft. the total capacity is as given above. Fig. 1 is a view of the "Alpena."

Taking first the steamer "Wyandotte," this is 310 ft. long, of the ordinary type of lake cargo boats, with boiler and engine placed at the extreme stern, and having numerous wide hatchways separated by narrow deck strips. The floor of the cargo space is formed as a double hopper (Fig. 2), the hoppers having gates for discharging the cargo upon two pan conveyors 36 ins. wide. These conveyors are 188 ft. long between centers of end sprocket wheels and are inclined upward 30° at the forward end, where they discharge into a hopper feeding a belt conveyor 42 ins. wide and 100 ft. long which is inclined 20½° in the opposite direction and rises through the deck, as shown in Fig. 3. This in turn discharges into a hopper or chute feeding another 42-in. belt conveyor which is carried by a steel-truss revolving boom 80 ft. long. It was at first intended to operate the conveyors by steam engines, but it was eventually decided to use electric motors. One 90-HP. motor drives the two pan conveyors and the inclined 42-in. belt conveyor; the boom conveyor is driven by a 35-HP. motor. On both steamers the boom is swung by means of a dinky engine or winch, a rope being attached to the head of the boom.

The pan conveyors, Fig. 4, have a speed of 60 ft. per min.; the two belt conveyors have a speed of 350 ft. per min. The pans are trough shaped, 18 ins. pitch, with 6-in. rollers riding on guide rails; the roller shafts are connected by ⅛-in. bars forming the chain links which travel over 42-in. sprocket sheaves at each end of the conveyor.

The "Alpena" (Figs. 1 and 6) is a rather larger boat, 370 ft. long over all. It has a double-hopper cargo space with two horizontal 36-in. steel pan conveyors, but the pans are of somewhat different shape from those of the other steamer, as shown in Fig. 4. These pan conveyors are inclined upward 30° at the bow, and discharge into a chute feeding a single return conveyor. In order to economize in space this latter conveyor is made much steeper than that of the "Wyandotte," and has an angle of 45°; as this made it impracticable to handle the required output of 750 tons per hour with a belt conveyor, a steel-pan conveyor is used, having a width of 54 ins. and running at 75 ft. per min. From the head of this conveyor, the material is delivered by a chute to a 36-in. belt conveyor on a steel boom. This conveyor is 77 ft. long between centers of conveyor pulleys, and the belt runs at 350 ft. per min.

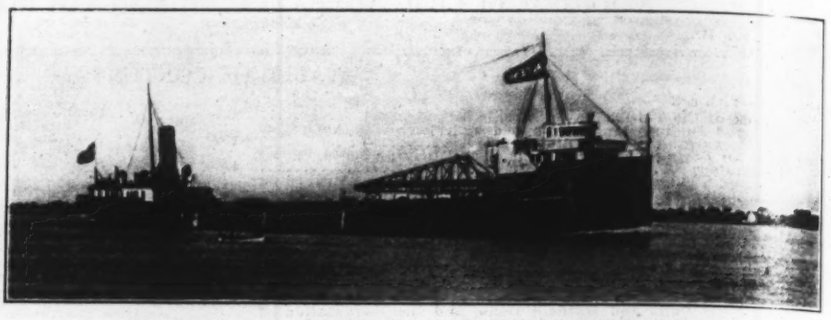

FIG. 1. THE LAKE STEAMER "ALPENA" (MICHIGAN ALKALI CO.), WITH CONVEYOR APPARATUS FOR DISCHARGING COAL AND CRUSHED STONE.
(The steel truss or boom carries a belt conveyor and is swung over the side when discharging; it is fed from other conveyors in the hold.)

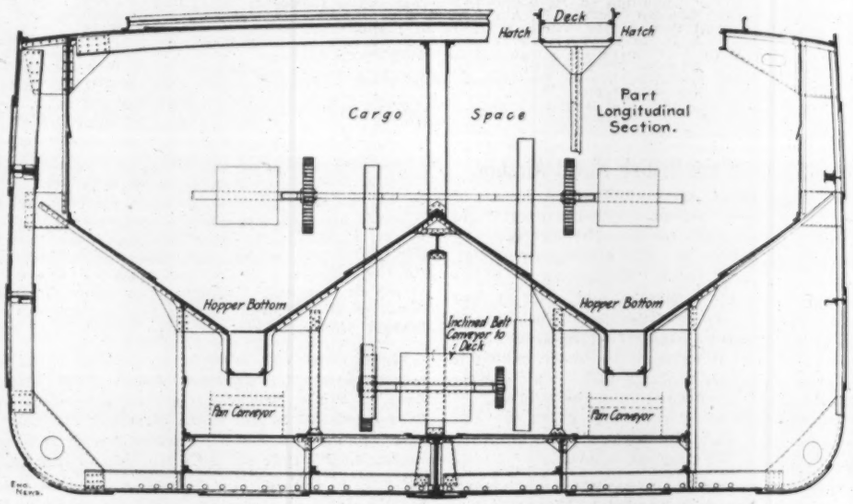

FIG. 2. CROSS SECTION OF STEAMER; SHOWING CARGO HOPPERS AND CONVEYORS.

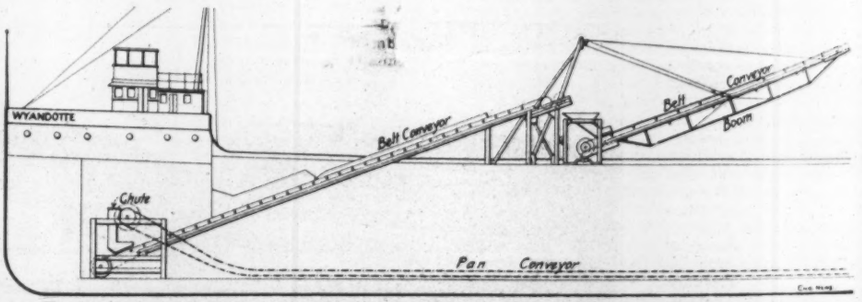

FIG. 3. PART SECTION OF STEAMER "WYANDOTTE," SHOWING ARRANGEMENT OF CONVEYORS.

The conveyors are driven by two horizontal compound engines placed near the bow, as shown in Fig. 6, one of which drives the two main pan conveyors. The other drives the inclined pan conveyor and the boom conveyor, the latter being driven through a vertical shaft and bevel gear. As the main conveyors are apt to become clogged at times the two engines are connected by a belt so that they can work together when necessary. The belt ordinarily rides loose, and is thrown into action by a belt tightener only when necessary. Steam for these engines is supplied from the main boiler by means of deck piping, as is usual for operating anchor hoists and deck winches.

A third arrangement proposed, but not yet applied to any steamer, has the intermediate conveyor (between the hold conveyors and the boom conveyor) replaced by a vertical bucket elevator. At the bottom of this are two side chutes to receive the material from the hold conveyors. At the top is a hopper with chute delivering the material upon the boom conveyor. This requires less length of the vessel than the all-conveyor arrangement.

Fueling Steamer with Conveyor Equipment.

The supply of fuel to lake steamers usually involves loss of valuable time, as the ship must go from the unloading point to the coaling point and tie-up to receive fuel. In many cases, however, fuel is delivered by lighters, being handled by wheelbarrows or by derricks and grab buckets. But even in this way it is rarely practicable to deliver a full supply of coal while the steamer is unloading its cargo. To facilitate this work and to reduce to a minimum the time-loss of the cargo boats, a self-propelling fueling lighter with conveyor equipment has been built by the Stephens-Adamson Co. for the Pickands Mather Co., of Cleveland, O., which uses it for supplying its own ore boats as well as those of other companies. This lighter, the "West Shore," was

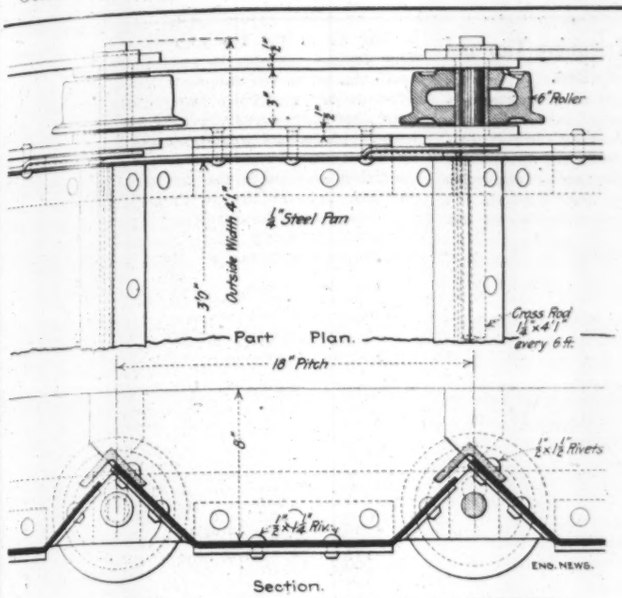

FIG. 4. PAN CONVEYOR OF STEAMER "WYANDOTTE."

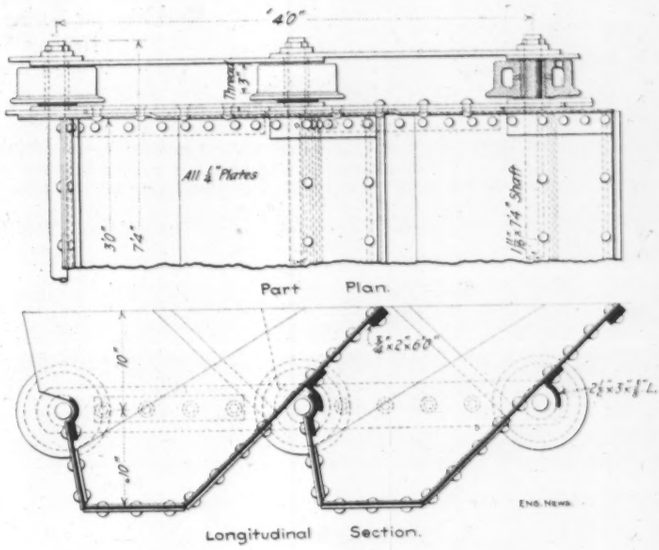

FIG. 5. PAN CONVEYOR OF STEAMER "ALPENA."

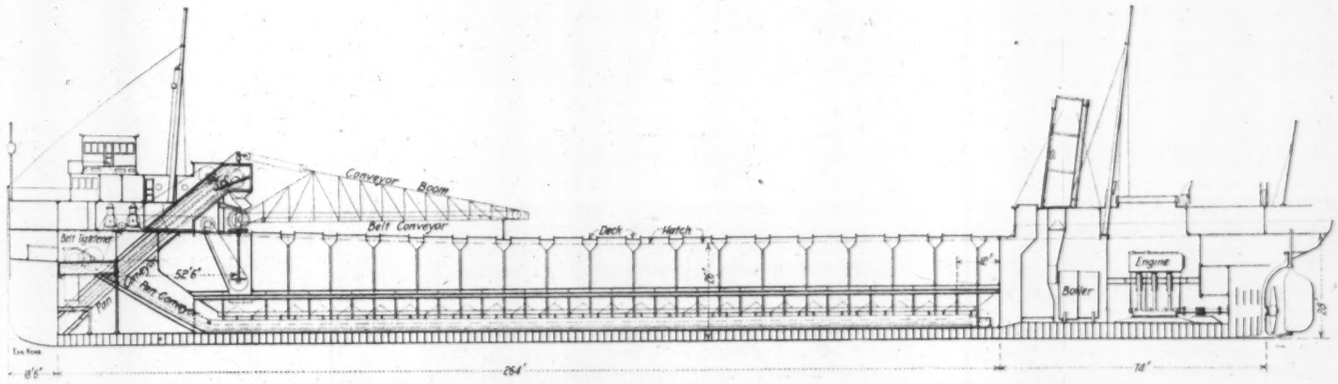

FIG. 6. LONGITUDINAL SECTION STEAMER "ALPENA" SHOWING ARRANGEMENT OF CONVEYORS.

put in service in 1910 and has frequently delivered coal into steamer bunkers at the rate of 500 tons per hour.

This lighter is 170 ft. long and 36 ft. beam, with a loaded draft of about 12 ft. The coal space has a double-hopper bottom and its sides extend above the deck so that it has a capacity of about 1,000 tons. It is divided into 18 compartments or hoppers of 50 tons capacity and four of 25 tons, so that it is easy to keep account of the coal delivered to steamers without weighing. The conveyor equipment has an unloading capacity of 500 tons per hour, and as a large ore steamer takes only 250 to 300 tons at a time, it can be supplied in a very short time. When a steamer arrives and needs coal, notice is sent to the lighter, which then comes alongside and delivers the coal while ore is being unloaded. If the cargo is unloaded before the full supply of coal is received, the steamer can start at once on its return trip, with the lighter lashed alongside When the fueling is completed the lighter is cast off and steams back to port. In the same way coal can be delivered to passing steamers.

The conveyor equipment of the lighter is shown in Fig. 7. There are two horizontal 42-in. pan conveyors, 57 ft. long, placed tandem and both delivering to a vertical bucket elevator having buckets 48 × 30 ins. This has a lift of 40 ft., and its upper part is housed in a steel tower, which also carries a hopper and chute for feeding a 42-in. pan conveyor on the revolving boom. This boom is 50 ft. long, and has at its outer end a hinged telescopic chute which is lowered into the bunker hatch, thus avoiding breakage and waste of coal. It will be noted that while the steamers above described have two parallel hold conveyors, each serving one row of hoppers, the barge has a single central conveyor to serve both rows of hoppers. To deliver the coal from the hopper gate to the central conveyor, there is a feeder beneath each hopper, as shown in Fig. 8. This consists of a trough having a horizontal reciprocating motion and riding on four loose rollers; the rollers are not pivoted but act as roller bearings, being supported in grooved runways. The troughs are of such length that when in their rear position they are not drawn back of the line of the angle of repose of the hopper load. The feeders are connected to eccentrics on a shaft carrying an iron friction pulley at each feeder. Along each side of the hold runs a main shaft carrying paper friction pulleys. The operation of the feeders is controlled by an operator on the deck above by means of a cable, each

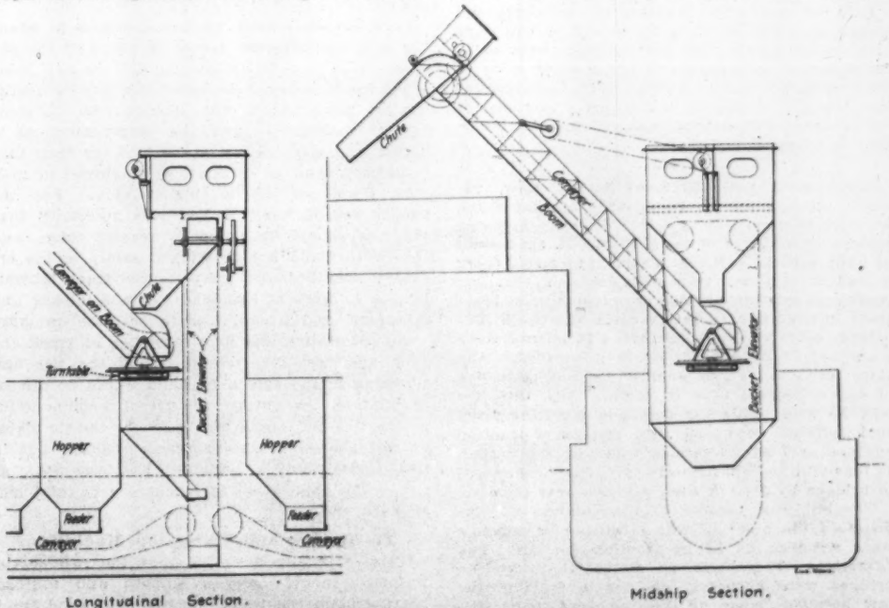

FIG. 7. PART SECTIONS OF FUELING BARGE, SHOWING CONVEYOR SYSTEM FOR DELIVERING COAL TO STEAMERS.

feeder being controlled separately. The cable operates an arm which turns the eccentric bearings supporting the end shaft, and thus brings the two friction pulleys into contact.

A somewhat similar conveyor equipment is located at the coal dock, so as to load the fueling lighter rapidly. Track hoppers under three tracks along the dock are served by a conveyor which delivers the coal to a hinged boom supported by topping lifts from a tower on the edge of the wharf or dock. The boom is 27 ft. long and carries a 48-in. pan conveyor discharging into a hinged adjustable chute.

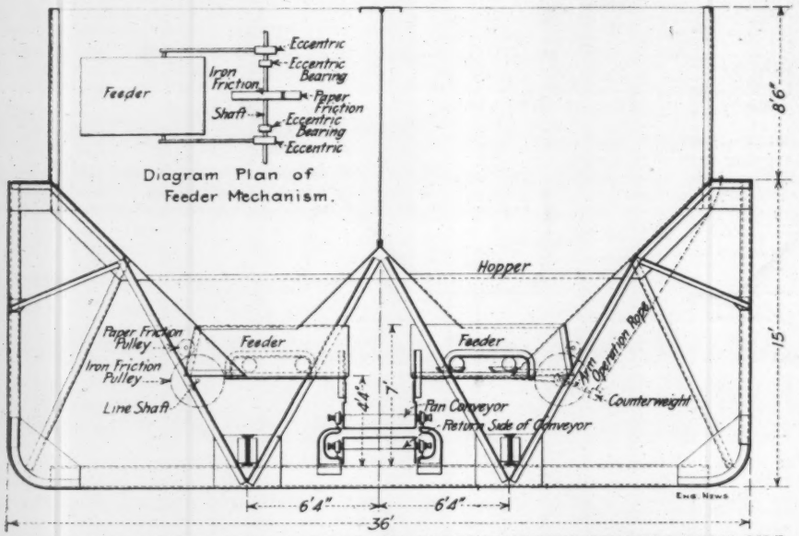

FIG. 8. PART CROSS SECTION OF FUELING BARGE, SHOWING FEEDERS FROM SIDE HOPPERS TO CENTRAL CONVEYOR.

The Possibilities of a Motor Battle-Car are mentioned, in an article on "Naval Power" by Rear-Admiral Bradley A. Fiske, U. S. N., in the September issue of the U. S. Naval Institute "Proceedings," as follows:

Nothing like a ship can be made to run on shore; but if an automobile could be constructed, carrying twelve 12-in. guns, twenty-one 5-in. guns and four torpedo tubes, of the size of the "Arkansas" and with her armor, able to run over the land in any direction at 20 knots, propelled by engines of 20,000 HP., it could whip an army of a million men just as quickly as it could get hold of its component parts. Such a machine could start at one end of an army and go through to the other like a mowing machine through a field of wheat; and knock down all the buildings in New York afterwards, smash all the cars, break down all the bridges and sink all the shipping.

It is not quite clear whether the knocking and smashing would be done by means of the guns or by ramming; but in case ramming were to be the order of procedure and the bridges were to be broken down by running this "automobile" upon them, it would do well to leave this part of the program until after the ships, cars and buildings had been demolished.

Wisconsin's New Highway-Bridge Law, recently enacted by the Legislature of that State, provides that no iron, steel or concrete highway bridges or culverts of more than 4-ft. span shall be built without sufficient strength to safely carry a load of 15 tons. It is provided, too, that any repairs to existing bridges or culverts must leave them in condition to safely carry this load. For bridges or culverts of less than 4-ft. span a minimum safe load of 18 tons is prescribed. Any town, city, village or county building a bridge or culvert which fails to comply with this law will be held liable for damages resulting from such failure. Conversely, the owners of traction engines or loaded vehicles weighing more than 15 tons will be held liable for any damages caused to bridges by driving such vehicles over them.

The bill was inspired by the number of accidents in the state in which bridges or culverts were wrecked by heavy traction engines. The "American Thresherman" states that wooden bridges were purposely omitted in framing the law because "some of the members from the northern part of the state feared it might cost their constituents too much in taxes to build decent bridges."

Machines for Boring and Trimming Ties and Driving Screw Spikes.

The screw spike has been in long and extensive use in Europe as a means of fastening rails to the ties, and has been proved by long experience to be an efficient and economical device, far superior to the common drive spike generally used in this country. Much has been written and said as to the advantages of this device for American railway track, especially where fast and heavy traffic is carried, but although a few important roads have taken it up, its use here is very limited and regarded mainly as experimental. An exception to this condition is the South Side Elevated Ry., of Chicago, on which screw spikes have been the standard railway fastening for several years. Of ordinary railways, the most extensive user of screw spikes is probably the Atchison, Topeka & Santa Fe Ry., which reports that its track laid in this way has proved very satisfactory. However, none of it has been in service for more than about two years, and therefore nothing can be said definitely as to the durability or cost of maintenance. At the same time, it is admitted that the present results indicate a decreased cost of maintenance. The Chicago, Rock Island & Pacific Ry. also is beginning a somewhat extensive use of screw spikes.

Perhaps one reason for the slowness to adopt the new and efficient device in place of the old drive spike is that its introduction on any large scale would necessitate some changes in methods of track work, the introduction of some special machinery, and the employment of a higher and more skilled grade of labor than that commonly (and unfortunately) employed in railway track service in this country. For the proper use of screw spikes it is necessary that the ties should be bored to receive them, and this work could not be trusted safely to the ordinary unskilled and inexperienced track laborer. But to do work of this kind by hand is slow and laborious, and where it is to be done on large numbers of ties and long stretches of track the time and cost involved in boring the ties and screwing in the spikes by hand would be almost prohibitive. In Europe, the use of machinery for boring ties and facing the seats for the tie-plates or rail chairs is very common practice, but in this country only a beginning has been made as yet in the application of machinery to this class of work.

Tie Boring and Trimming Machines.

It is extremely desirable that the rail or the tie-plate should have a smooth and uniform bearing upon the tie, to ensure both good track construction and long life of the tie. Under average conditions, however, such a bearing is far from universal, either for the opposite ends of one tie or for any number of adjacent ties. The ties are uneven in shape, line and surface; and even when the rail seats are dressed with an adze, it is practically impossible for the adzeman (however expert he may be) to secure uniformly plane and even surfaces on any one tie or on a number of adjacent ties. As to this condition, we quote the following from a paper on "The Conservation of Cross Ties by Means of Protection from Mechanical Wear," by Mr. J. W. Kendrick, formerly Vice-President of the Atchison, Topeka & Santa Fe Ry.:

When it becomes necessary to renew rails in main line service, what happens? Usually the new rail is of heavier section than that it replaces. The ties are already cut by the rails of lighter section having a narrower base, or even if the rail is the same in section, the ties are nevertheless cut, and before the new rail can be placed it is indispensable that the tie should be adzed. The labor is usually unskilled, and it is regretable that it is becoming more so each year. The adzes speedily become dull. Some ties are practically uncut; others are cut by varying degrees up to perhaps an inch or two inches, and with dull tools an attempt is made to bring them to a proper surface to receive the new rails. The result is that they are mutilated, some of them are cut one-third through, depressions are formed which gather and hold moisture, the old spike holes (plugged or unplugged) are covered or partially covered by the base of the rail, spikes are driven in new places, and the ties are left in such a condition that they are peculiarly receptive to moisture and germs that cause decay. You will find this condition of affairs on every railway in the United States.

Such work can be done quicker and more effectively by machine, for new ties at least; and more economically also, if large numbers of ties are to be handled. As far as boring spike holes is concerned, this is essential for screw spikes, while an ordinary spike will have greater holding power and do less injury to the wood of the tie if it is driven in a small bored hole. However, the boring of ties for drive spikes is practiced to but an extremely limited extent in this country, and may be considered as negligible. For ties which are to be treated by preservative processes, all trimming, facing, boring, etc., should be done before the treatment, so that there will be no cutting away of the treated wood and so that the preservative will be applied to all the faced surfaces of the wood.

The Atchison, Topeka & Santa Fe Ry. is one of the few American railways to go extensively into the question of the use of screw spikes and of machinery for boring and facing the ties. In addition to some small machines (noted later), which resemble motor section cars and are for use on the track, it has some large machines for handling the ties before they are laid in the track. These are portable machines which can be sent to any part of the line. During the past summer, two of the machines have been in use; one at the tie-treating plant at Somerville, Tex. (Engineering News, May 3, 1906), and the other in the laying of new second track in Arizona, for which screw spikes were used. These machines not only bore the ties for the spikes, but dress the faces to give a proper bearing for the rails or tie-plates. The machine at Somerville is shown in Fig. 1.

At the Somerville plant, the ties are finished in this way before being subjected to the preservative treatment. Here, the machine has handled about 3,000 ties per day (mainly softwood ties); it has handled as many as 3,600 in a day, and for an entire month it averaged 3,200 ties per day. On the work in Arizona, the new second track is laid with ties of Japanese oak, and with this hardwood timber the machine handles from 2,200 to 2,400 ties per day. Some improvements in the machines are being made, as the result of experience, and it is considered that when these are completed they should be able to bore and adze 3,600 softwood ties or 3,000 hardwood ties in a ten-hour day.

For dressing the ties at tie-storage yards or at tie-treating plants, it is usually preferable to have the machines installed in a building and served by conveyors. This is generally the most convenient arrangement, but in some cases, however, it is cheaper and more convenient to take the machines to the ties, as at very large yards, and in such cases the machines are mounted on cars. This latter arrangement also enables the work to be done on the open road as in tie renewals or track reconstruction. This practice is

followed by the Atchison, Topeka & Santa Fe Ry., which has two cars of the type shown in Fig. 1. The tie boring and adzing machine is mounted parallel with the rails, and served by an inclined conveyor reaching from the car floor to the ground. The conveyor consists of two parallel steel frames, with transverse connections, each frame carrying an endless link-belt chain with dogs for feeding the ties forward. The trimming saws are not used on these portable plants, owing to the amount of extra machinery required. The car is usually equipped with a six-cylinder 60-HP. gasoline engine, with its gasoline and water-supply tanks and radiators, arranged for driving the machine and propelling the car about the plant. The car is also equipped with tools for making ordinary repairs and a grinder for the knives used on the adzing heads.

The tie-boring and tie-adzing machines were designed and built specially for this class of work by Greenlee Bros. & Co., of Rockford, Ill., who are manufacturers of wood-working machinery. They are of simple design and heavy construction, so that they are not liable to get out of order even under conditions of severe service and rough usage. They are also largely automatic in action, so that very little work is required of the operator except to handle the levers and to see that the work goes on properly. Laborers load the ties upon the feed conveyors, and remove them from the discharge conveyors, The machines adapt themselves to the size of the tie, so that there is no necessity for selecting or trimming the ties in advance. The following description of the machines is condensed from information furnished by the makers. It will be noted that the trimming saws (for uniform length) and the device for dating the ties are accessories quite independent of the main purpose of the machine. As a matter of fact, the dating of ties by means of stamps has not proved very satisfactory in track service.

The tie-boring and adzing machine is shown in Fig. 2. It consists of an adzing arbor equipped with double cutting heads, two sets of boring spindles (with either two, three or four spindles in each set), and reciprocating automatic feed mechanism, all mounted on a heavy cast-iron main frame. The machine may be further equipped with discharging conveyors, arranged to be raised or lowered so that ties may be delivered conveniently into any car. The countershaft at the rear of the machine may be directly coupled to a motor, and separate countershafts are provided for driving the boring spindles and cut-off saw, or the boring spindles may be driven by spur gearing direct from the main shaft. Automatic pressure bars hold down the ties while over the adzing heads, and automatic clamps hold them while being bored. The automatic feed is accomplished by sets of reciprocating dogs on each side of the machine, actuated by a positive cam and lever movement. These sets of dogs are mounted on slides fitted in the side frames, and project in front of the machine far enough to carry the ties to and through the cutter heads, without the necessity of the operator placing them dangerously near any moving parts even when no special feed conveyor is used. There is also an exhaust system (with fan, hoods and piping) for removing the shavings, chips and sawdust and conveying this refuse outside of the car or building.

The steel tracks upon which the ties are carried over the adzing and boring heads are placed directly alongside of the adzing heads, so that the depth of cut is measured from the nearest possible point on the face of the tie to the location of the cut. This feature is necessary, since irregularly formed ties could not be properly machined except by resting them on a point as near as possible to the place where the cuts are to be made. These tracks are heavy steel bars mounted on wedges, so connected that they can be raised and lowered by a hand-wheel placed conveniently to the operator, and any depth of cut thus obtained.

The adzing heads are of gun-metal bronze fitted with solid steel cutting knives, and expanding to cut to any width necessary to suit the tie-plates to be used. Two heads are provided, one for each end of the tie. Both are mounted on a large crucible-steel spindle running in long self-oiling bearings and driven by a heavy belt (having an adjustable tightener) direct from the main countershaft. The pressure bars at the adzing heads serve to hold the ties while the cutters are operating; these are attached to long heavy weights suspended from above by four connecting links, forming an independent parallel guide at each end of the tie. Passing under these the tie adjusts itself to an average level position of its uneven surface, and is carried over the adzing heads without any rocking motion. Thus the two surfaces for the tie-plates are formed in exactly the same horizontal plane.

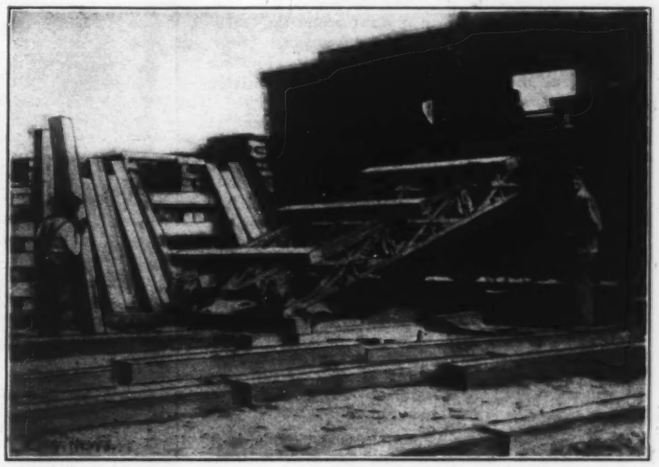

FIG. 1. TRAVELING MACHINE FOR BORING TIES AND FACING THEM FOR TIE-PLATES; ATCHISON, TOPEKA & SANTA FE RY.
Greenlee Bros. & Co., Rockford, Ill.; Makers.

The boring spindles may be of any desired number, placed in clusters at either side of the machine, and directly to the rear of the adzing heads. While the regular design is for boring vertical holes, these heads can be adjusted to bore holes at an angle, if desired. They are driven by gears from a countershaft within the base of the machine, and this shaft may be driven either by belt from overhead or by spur gears from the main countershaft. They are adjustable in all directions and are equipped with special clamping devices operated from the main feed cam shaft. These clamps automatically close upon the tie when it arrives in the proper position over the boring spindles. Any practical number of spindles can be provided and any one (or more) may be cut out of action by sliding back its driving gear, and omitting its bit. A counting device records the number of ties passed through the machine. The necessary shavings exhaust outfit is also furnished, as well as a positive pressure blower with connections for removing the borings from the auger bits.

Trimming saws may be mounted on heavy cast-iron brackets at the front end of the machine and driven by belts from overhead countershafting. These saws are of sufficient diameter to trim the largest ties and have longitudinal adjustment for variation in length of tie. A pneumatic branding device may be applied consisting of two opposed cylinders with pistons provided with dies for stamping dates (or other information) and controlled by automatic air valves. This device may be placed directly behind the boring spindles and so timed to the machine feed that when the tie moves to the proper position the dies advance and leave their impression in either end of the tie.

The operation of the tie adzing and boring machines is entirely automatic from the time the tie is deposited on the feed conveyor. From the point where the ties are deposited on the guide tracks they are picked up by automatic reciprocating dogs and passed to a point close to the trim saws (when a machine is so equipped) or in front of the adzing heads. When the trimming is done a second set of dogs passes the ties, between the saws and under the first set of pressure bars. Following this operation they are moved by another set of dogs to the position directly in front of the adzing heads, where other dogs receive them for passing over these cutter heads and under the pressure bars.

Having now been adzed (or trimmed and adzed), the ties are moved forward to a position over the boring spindles, where they are gripped by the automatic clamping device and accurately centered directly above the spindles. The boring bits then feed upward and withdraw, the clamps are released and a set of dogs moves the ties forward and either deposits them opposite the pneumatic branding device, or drops them out of the machine or on the feeding-out con-

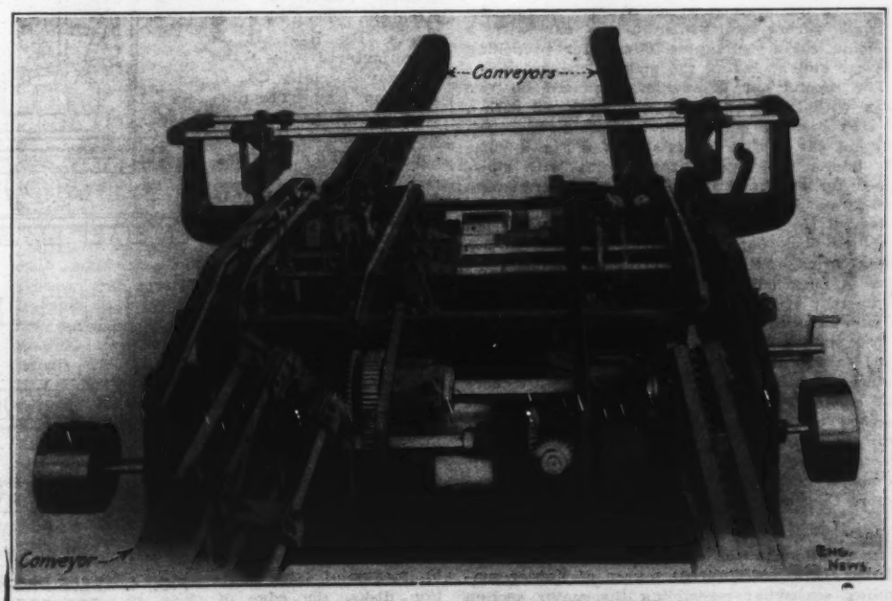

FIG. 2. TIE-BORING AND ADZING MACHINE.
Greenlee Bros. & Co., Rockford, Ill.; Makers.

veyors. Where the branding device is used the ties remain at rest for an instant while the pneumatic cylinders drive the dies forward. When this operation is included in a machine another set of dogs moves the tie from its last position and deposits it on the conveyor.

The standard machine is built with a range to handle any tie from 5 × 7 ins. to 8 × 12 ins., and of any length up to 9 ft. Its bits will bore any depth to 12 ins. When equipped with two sets of four boring spindles each, these spindles can bore any required diameter of spike hole, spaced not less than 4 ins. nor more than 6 ins. c. to c. for the pairs across the tie, and not less than 5½ ins. nor more than 8 ins. c. to c. lengthwise of the tie. The special machine will handle ties from 5 × 7 ins. up to 10 × 14 ins. and up to 9 ft. long. Its bits will bore any depth to 9 ins. and its heads cut any width to 12 ins. When equipped with any number of boring spindles, those in either set can be spaced up to 9 ins. c. to c. lengthwise of the tie.

Most machines are provided with an endless chain conveyor, although they are also built to simply drop the tie outside of the machine frame. The conveyor receives the ties as they leave the machine and deposits them in a car or truck. By its use hand labor is reduced to the minimum. The number of men required to keep the machine steadily supplied with ties depends somewhat on conditions, but usually either two or three men can handle and feed the necessary work. During the travel of the ties through the machine no attention is necessary other than that the operator should carefully watch them from his position at the controlling levers.

Tie-Spiking Machines.

As stated already the use of machinery for driving screw spikes is almost essential for economical work where such spikes are in use to any extent. The Atchison, Topeka & Santa Fe Ry. has two spiking cars for this work, and both of these were built and equipped by Greenlee Bros. & Co. The first is a double-truck steel-frame flat car with three machines mounted on the steel girder which forms the center sill, and driven from a longitudinal shaft. Each machine has two swinging arms of sufficient horizontal radius to cover four ties, and each arm carries a vertical spindle having at its lower end a socket to fit the spike head. The driving heads carrying the arms can be shifted longitudinally by a power device, but the makers consider it preferable to have them fixed, and in such case the spikes can be driven in 12 ties before moving the car. A reverse motion is provided, so that spikes can be removed from the ties. The machinery is operated by a Westinghouse steam engine of 75 HP., and the service of a locomotive is required to propel the car and to supply steam to the engine. It is intended to remodel this, however, and to equip the car with a gasoline engine supplying power for propelling the car and operating the spiking machines.

The second car is smaller, mounted on two axles with 12 ft. wheelbase, and equipped with a 60-HP. gasoline engine for spiking and propelling. A car of this sort is shown in Fig. 3. The car has a three-speed transmission with slow-speed for starting, 8 m. p. h. for intermediate and 20 m. p. h. for high speed. It is sufficiently powerful to haul a car carrying track material. This car has but one driving head, with two radial arms, each arm carrying a spiking spindle. A more efficient arrangement is considered to be that of the double machine, shown in Fig. 4, which has two driving heads and four spindles.

The spiking machines described above can be used in the tie-storage yards or at convenient points along the line, or they can be used to bore and spike ties already in the track. The last method of working can be used economically only (as a rule) for old ties in which it is desired to use screw spikes. Under other conditions it is usually cheaper and better to bore the ties before they are placed in the track.

Light Track-Spiking Machines.

In addition to the larger machines described above, there are different makes of lighter machines, somewhat resembling the motor section cars now very generally used for track work,

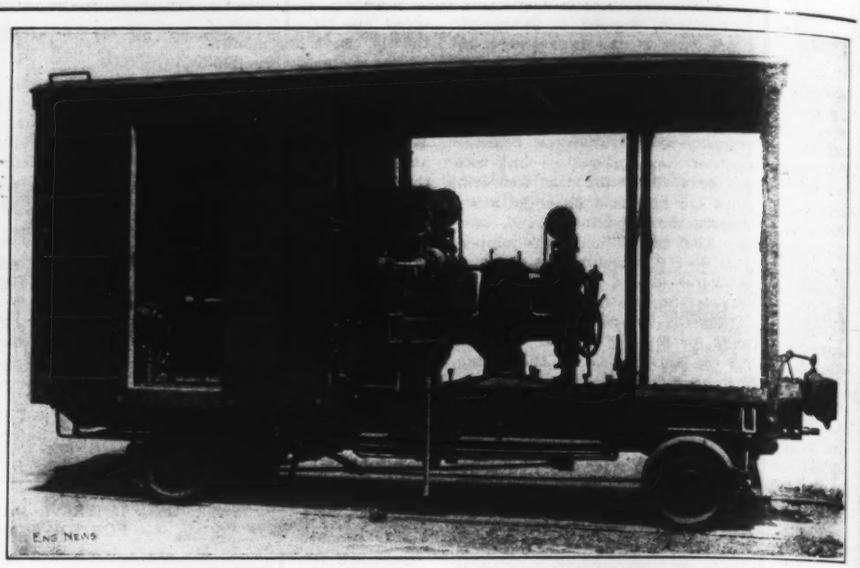

FIG. 3. SELF-PROPELLING MACHINE FOR BORING TIES AND DRIVING SCREW SPIKES.
Greenlee Bros. & Co., Rockford, Ill.; Makers.

bridge and signal repairs, and general inspection purposes. These can be used for boring and spiking ties in the track.

THE COLLET MACHINE.—As long ago as 1899, Mr. Albert Collet, a French engineer, invented an electric screw-spiking machine which has been used on different roads. In this machine, described in our issue of June 23, 1909, a steam-electric generating plant was mounted on a truck and supplied current to a pair of overhead wires supported by portable A-frames. A small wheeled trolley riding on the wires carried the end of a conductor cable leading to the truck on which were mounted the motors of the spiking machines. Each motor was carried by a swinging frame having a horizontal shaft connected at one end to the motor and at the other end (by bevel gear) to the vertical spiking spindle.

THE AUTRAKAR MACHINE.—This is a gasoline motor car, equipped with flexible shafting (or rigid shafts having flexible joints) for transmitting power to operate track tools, such as for boring ties, driving screw spikes, drilling bolt or bond holes in rails, etc. This machine, which was described in our issue of April 2, 1908, is the invention of Mr. H. W. Jacobs, Assistant Superintendent of Motive Power of the Atchison, Topeka & Santa Fe Ry. It is manufactured by the Railway Specialty Co., of Atchison, Kan. The railway named has four of these machines in use, equipped for driving screw spikes.

THE GREENLEE MACHINE.—This also is a gasoline motor car, and is light enough to be put on and off the track by the gang accompanying it. It can be run at speeds as high as 20 m. p. h. It has a wood frame, reinforced and trussed with steel; and is mounted on wood-center or insulated pressed-steel wheels with tubular axles and bronze bearings. The engine is of the horizontal two-cylinder opposed type, driving the mechanism by means of large friction disks, the edge of one disk bearing against the face of the other. The power is transmitted to one of the axles by a driving chain and to the spiking mechanism by cut gears. The friction drive permits of variation in speed, driving the car in either direction, and driving or removing the spikes.

The important feature is the combined boring and spike driving head. The spike-driving spindle is a hollow tube driven at a slow speed, while the bit spindle is of crucible steel carried within the spike-driving spindle and driven at a higher speed. All spindles and driving gears are of steel, accurately machined, and mounted in an oil-tight case, packed with graphite grease. The driving head may be swung to position over the tie, the boring bit fed down through the spike-driving sleeve, the hole bored, and the bit drawn back. The sleeve may then be fed downward and the spike driven, without changing the location of the head. These feeds are controlled by separate hand levers, and no interference is possible between the bit and the spike chuck. A collar on the outer sleeve, bearing against the side of the rail, gages the location of the holes.

When the car is equipped with one boring and driving head this is pivoted at the center of the

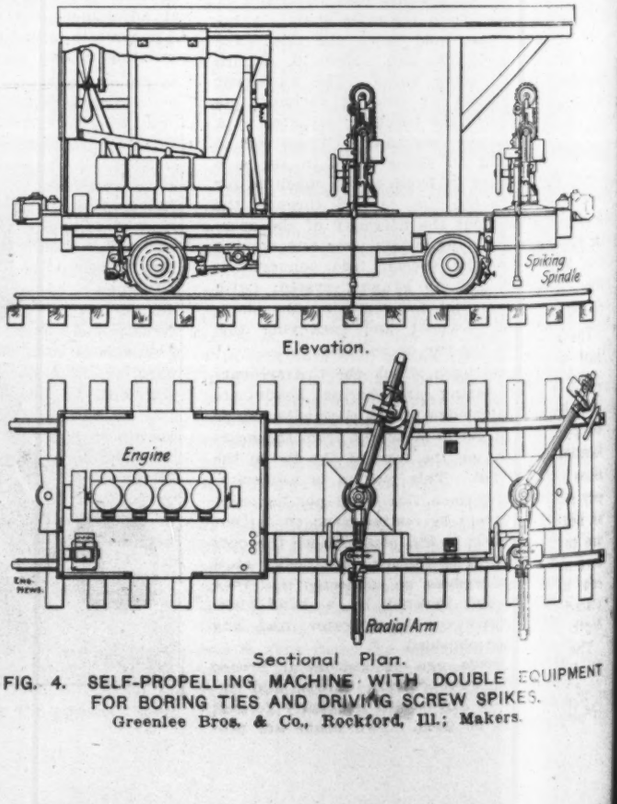

FIG. 4. SELF-PROPELLING MACHINE WITH DOUBLE EQUIPMENT FOR BORING TIES AND DRIVING SCREW SPIKES.
Greenlee Bros. & Co., Rockford, Ill.; Makers.

car and swings across the entire width of the track, so that work may be done on either rail or on any switch rail between the rails of the track on which the car is operated. When two heads are provided one is mounted near either side of the car. This machine is built by Greenlee Bros. & Co., of Rockford, Ill.

THE SNOW MACHINE.—While this is of the same general type as the two preceding machines, it is notable (1) for being designed on the lines of automobile construction rather than on those of the ordinary type of motor section car, and (2) for having a gasoline electric plant supplying current for electric tools. In this latter respect the machine is somewhat similar to that of Mr. Collet (noted above), but much simpler in construction and operation. The general design of the machine is shown in Fig. 5. It is the invention of Mr. T. W. Snow (formerly of the Otto Gas Engine Works), and is equipped with an Otto gasoline engine. It will be one of the specialties of the T. W. Snow Construction Co., of Chicago. One of the machines has been in use for some months on the Chicago, Rock Island & Pacific Ry., experimental work being conducted to determine the proper number of men and the best tool equipment for performing the most efficient work.

HAND MACHINES FOR DRIVING SPIKES.—While power machines are most effective for driving screw spikes, it may be necessary in many cases to apply them by hand, and to bore the ties in the track by hand also. This may be done by T-handled augers and socket wrenches, or by some form of manually-operated machine. The Smith machine, mounted on a frame set outside of the rail and operated by a crank handle was described in our issue of Aug. 25, 1909. The Greenlee Co. has a somewhat similar machine, but with two bits to bore the spike holes for one rail simultaneously; the spindles can be adjusted to any desired spacing of the hole. Double-throw cranks are used, driving the spindles by means of spur and bevel gears. As an intermediate device, there is the ratchet spike-driving wrench, made in two forms by the Greenlee Co. In one of these a horizontal cross handle revolves the spindle (with its socket end) by means of a ratchet; in the other, the handle is given a pump-handle action, communicating motion to the spindle by means of two bevel gears on the ratchets engaging with a bevel wheel on the head of the spindle.

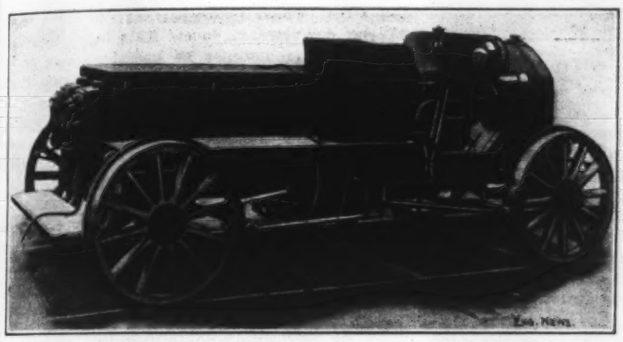

FIG. 5. GASOLINE-ELECTRIC MACHINE FOR BORING TIES AND DRIVING SCREW SPIKES.
T. W. Snow, Chicago; Designer.

The car has a 30-HP. four-cycle four-cylinder gasoline engine, with a transmission affording three speeds in either direction (from 10 to 40 m. p. h.). The generator, supplying current for the tools, is of 6½ KW., 125 volts, 52 amperes, running at 1,000 r. p. m. The gasoline tank has a capacity for 15 gallons, or sufficient for a day's work. The 30-in. wheels are of the artillery type, and the frame is mounted on elliptical springs. The spiking equipment includes two electric spike screwing machines and six electric drills, as three spikes can be driven in the time it takes to bore one hole. There are also an electric saw (for cutting rails), an emery wheel, and such other tools as may be required for special work. The machine carries a long cable which enables work to be done at a distance from the car, the cable having plug-in switches for tool connections at intervals of about 20 ft. The machine can carry from eight to ten men. It has a wheelbase of 8½ ft. and weighs about 3,000 lbs.

THE DUNTLEY MACHINE.—This is a gasoline-pneumatic machine, the gasoline engine propelling the car and operating an air-compressor which supplies the pneumatic tools. It is built by the Chicago Pneumatic Tool Co.

ELECTRIC AND PNEUMATIC TOOLS FOR SPIKING.—With most of the machines described above (except those of the largest class) each boring or spike driving tool is held in position by one or two men, who also move it from place to place. On electric railway construction, electrically operated drills and wrenches may sometimes be used without the assistance of special machines to supply the power. Such tools have been used extensively in the track reconstruction of the Chicago street railways; each tool is held by one or two men, and current is taken by means of a wire led up a light rod which is hooked upon the trolley wire. This was described in the article on the track reconstruction of these lines in our issue of Nov. 3, 1910. Pneumatic drills of the same sort, but operated by air conveyed through hose, have been used in some cases as on bridge work where a work car with compressor plant was available.

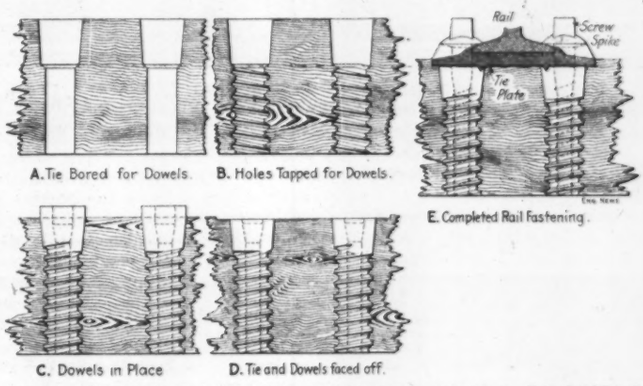

FIG. 6. FITTING A TIE WITH HARDWOOD DOWELS TO RECEIVE SCREW SPIKES.

Hardwood Dowels for Softwood Ties.

While softwood ties are often advantageous and economical in track service, especially when treated by preservative processes, they have the disadvantage of giving a comparatively slight hold for the spikes; this hold decreases as the ties wear, as the wood decays or softens, and as the spikes work loose and are redriven. This difficulty applies both with screw spikes and with drive spikes. In Europe, means of remedying this defect have been used extensively for a number of years. One of the simplest means is the driving of a square or circular plug of wood at each spike hole, the plug being made hollow to receive either a screw or drive spike. This method, invented by Mr. Frederica, of Denmark, was patented in this country in 1902 (Engineering News, June 18 and 25, 1903), but we do not know that it has ever been put into practice here.

A more elaborate method is to bore a hole at each spike position, tap this with a coarse thread, and screw into it a threaded plug or treenail of hardwood, which itself is hollow and may be threaded to receive a screw spike. This method was invented some 15 years ago by Albert Collet, and has been used extensively both in France and Germany, giving very satisfactory results where softwood ties were employed (Engineering News, May 20, 1909). In the Thiollier system, the hole is bored and tapped, but a steel spiral or helix is screwed into the tapped recess seeming by its pressure to compress the wood of the threads. Into this part of the wood, the thread of the screw spike cuts its way. This device has been used extensively abroad and has been tried in this country on the Pennsylvania Lines (Engineering News, June 21, 1906).

The question of how to get the maximum efficiency of service out of railway ties was studied very carefully by Mr. J. W. Kendrick, while Vice-President of the Atchison, Topeka & Santa Fe Ry., and in 1909 he presented before the American Railway Engineering Association a paper on "Conservation of Cross Ties by Means of Protection from Mechanical Wear." He came to the conclusion that four steps (in combination) are necessary to adapt ties of softwood to economical life and service: (1) preservative treatment of the tie to prevent decay; (2) the use of metal tie-plates of such design as to properly distribute the heavy pressures from the rail base to the tie; (3) the use of screw spikes to hold the rail, and (4) the use of wooden screw dowels or plugs bored in the center to receive the screw spikes. As a result of his study he designed and patented a method of applying these dowels, and the several steps are shown in Fig. 6. The track machine already mentioned, and illustrated in Fig. 7, is equipped for this sort of work. It resembles an open-side box car of steel construction throughout. This car is equipped also with machines for putting hardwood dowels in the ties, on the system described later. On each side of the car there is a set of four machines for (1) boring, (2) tapping, (3) screwing in the dowel, and (4) facing the rail seat. Thus eight ties can be handled at one time. Hinged footboards are provided for the machine operators, as shown.

The operations are performed before the tie is treated, and each is performed by a separate machine. In the first machine, four 1¼-in. holes are bored simultaneously (two at each end), being slightly staggered so that they are on opposite sides of the center line of the tie; the top of the hole is reamed out also (A, Fig. 6). The second machine taps a coarse thread in the lower part of the hole (B, Fig. 6). The third machine screws in the hollow threaded dowels (C, Fig. 6); and the fourth machine turns off the projecting top of the dowels and faces the tie to receive the tie-plate (D, Fig. 5). The ties then go to the treating plant. The plugs are slightly tapered at the top and when screwed home make a tight fit. Each plug has a ⅝-in. hole for the spike. At (E, Fig. 6) is shown the completed rail fastening.

This doweling system has been used on the A., T. & S. F. Ry., but only to an experimental extent. The first track machine that was built (Fig. 7) was designed for boring ties and inserting dowels; it was used also for boring ties for screw spikes until the adzing and boring machines were put in use, but since then it has not been in service. It was built by Greenlee Bros. & Co., of Rockford, Ill.

About 50,000 dowels were put in new ties as an experiment, with the purpose of testing the strength of ties after being bored to such an extent as to receive the dowels. About 300 old ties with spike holes (using drive spikes) were taken out of the track, bored, fitted with dowels, replaced in the track and then fitted with screw spikes. This is the extent of the work done in the line of using dowels, and the idea does not seem to have been taken up by any other railway. We quote the following from Mr. Kendrick's paper, but it is evident that much of the

improvement estimated is due to the screw spikes rather than to the dowels.

The question will naturally be asked as to the relative cost of adopting this form of construction as compared with that now in use. A proper machine at the treating plant will bore and plug 600 ties with 8 plugs each, per day of 10 hours, at a cost of 3½ cts. per tie. The cost of making the plugs will be about 1½ cts. each. The cost of screw spikes will be 2.7 cts. each; of tie-plates, 21 cts. each. The cost of cut spikes will be 1.06 cts. each. Assuming 3,000 ties per mile of track, with four spikes per tie, assuming that the same types of tie plates are used both with screw and cut spikes, and that eight wooden dowels are provided for the plates with screw spikes,

FIG. 7. TRAVELING MACHINE FOR BORING TIES AND FITTING THEM WITH HARD-WOOD DOWELS FOR SCREW SPIKES; ATCHISON, TOPEKA & SANTA FE RY. Greenlee Bros. & Co., Rockford, Ill.; Makers.

and no dowels are provided for cut spikes, the relative cost per mile of track would be as follows:

One Mile of Track with Screw Spikes and Dowels.	
12,000 spikes at 2.7 cts.	$324
6,000 tie plates at 21 cts.	1,260
Boring ties for, and driving, 24,000 dowels, at 1 ct.	240
24,000 wooden dowels, at 1½ cts.	360
Driving screw spikes (per mile)	150
Total	$2,334

One Mile with Cut Spikes.	
12,000 spikes	$127
6,000 tie plates, at 21 cts.	1,260
Driving cut spikes (per mile)	150
Total	$1,537

The difference in cost is considerable. The calculation assumes that tie-plates will be used in either case, and true economy requires that this be done. The estimated cost of driving screw spikes is based upon work actually done under unfavorable conditions on a section of track about five miles in length, on the Illinois Division of the A., T. & S. F. Ry. Unfortunately, the holes in the tie-plates were a little too small, so that the screws acted as reamers to enlarge the holes before they could be driven home. The record of cost for driving 4,200 track-feet (the best progress made in one day) indicated that there would be little or no difference between the cost of applying screw spikes and of driving cut spikes.

The element of increased cost is one which enters into any construction of superior type, and the real question is: Is it worth while? If this process is followed, the average life of ties on American railways would be, very conservatively speaking, 21 years instead of about 7; that is they would last three times as long as at present. Screw spikes should be applied as ties are renewed. Then at the end of a period of from 7 to 10 years any line of railway pursuing this course would have provided its track with treated ties, screw spikes, and so forth.

An Oil-Engine Driven Ship has crossed the Atlantic from the Tyne, England, to Halifax, N. S., where it arrived Sept. 22, according to a report published in "Engineering." This vessel, the "Toiler," is given the credit of being the first of its kind to complete a Trans-Atlantic voyage. The "Toiler" is not intended, however, for regular Trans-Atlantic service, being destined for use on canals in Canada. The vessel has twin propellers driven by two-cycle reversible Diesel engines built by the Aktiebolaget Diesels Motorer, of Stockholm. The ship itself was built by Swan, Hunter & Wigham Richardson, Limited, an English company. The fuel consumption for the trip is claimed to have been less than two tons of crude oil per day, against about eight tons of coal for a steamship of equal power.

Some Thoughts Suggested by the Austin Dam Failures Regarding Text Books on Hydraulic Engineering and Dam Design in General.

By JOHN R. FREEMAN,* M. Am. Soc. C. E.

First of all let me thank the editor for his excellent editorial in the past week's issue of Engineering News relative to engineering supervision of dam building. I would only place more emphasis on the point that such a structure after being properly designed should have responsible expert inspection, day by day and hour by hour while being built, to disclose defects in substrata, as well as to make sure of quality in the dam itself, adding to the design if need be.

As to the present popular movement for Governmental examination of all dams, it is well to remember that it is impracticable for State inspectors appointed at this late day to learn all the important facts about a structure built fifty years ago, or even one year ago. The factor of safety when reviewing old structures should, therefore, be large.

I spent a part of yesterday inspecting the ruins of the Austin, Pa., dam, and a few months ago I spent some hours studying the ruins of the dam at Austin, Texas. At neither place is the bedrock directly beneath the dam site now visible; but at both sites a reliable idea of its character can be obtained by studying the neighboring outcrops. It is the thoughts aroused by considering the character of these bedrocks that have prompted the following communication, while interest and discussion are most active,—rather than wait as I would like to for the furthest possible information about every one of the conditions.

At Austin, Pa., I found the rock exposed in the bed of the small stream and by the scour of the flood, at a point nearly opposite the ruins of the Bayless Pulp Mill, perhaps one third of a mile downstream from the dam. Here it had a nearly horizontal stratification much the same as in the quarry at a higher level close to the westerly end of the dam. It appeared to be a hard, shelly sandstone laid down in thin loosely adherent strata. Presumably the same condition prevails underneath the dam, but it would be worth while to clean off a considerable area to make absolutely sure about this feature while investigating the causes of failure. Subject to further information it appeared to me that in this seamy character of the bedrock of these Austin dams, and in the lack of proper precautions to meet this condition is found the immediate cause of both failures.

Some years ago I had occasion to study the plans and reports concerning the dam at Montgomery, Alabama, which failed after a widespread storm which wrecked three important dams on Southern rivers. I was then led to note that many or most of our standard books on applied mechanics, masonry construction and dam design have little to say about the danger of uplift pressure within or beneath a high masonry dam and the great importance of providing against it.

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I am writing in a railroad car, on my way to Mexico and without access to my library, or I would call your attention by chapter and verse to the scant attention given to this matter in various standard text books, even in such pretentious treatises as that of Wegmann, and also to their scanty consideration of ice pressures, temperature strains and conditions affecting erosion of bed and banks.

While most authors mention uplift, they do not give a sufficiently strong warning to the novice against its dangers; but limit their few words of caution to bad, seamy bedrock, disregarding the fact that uplift pressures may possibly occur under or within almost any masonry dam and should always be allowed for.

It is hardly too much to say that the chapter on the design of masonry dams in nearly all of our text books should be rewritten; and before rewriting, the authors would do well to read over and over again that remarkably lucid and thoughtful contribution to this subject by the late James B. Francis in the "Transactions of the American Society of Civil Engineers," some 25 years ago, relating particularly to the design of the proposed Quaker Bridge Dam.

Most of our text books put their emphasis on overturning and crushing, and advise a somewhat extravagant factor of safety against crushing, on the basis of a theory of uniformly varying stress which tends to exaggerate the stress at the downstream face. This large factor of safety may sometimes be useful so long as ice pressures, temperature stresses, shrinkage effects and percolating effects are ignored.

The careful engineers who designed the Wachuset Dam, the Ashokan Dam and many of our other large American dams have not overlooked these matters; and this is another illustration of how far the text books often lag behind the best practice of engineers. As I read the lesson of the two Austin dam failures the following facts are plain:

First, the loss of life and property that would follow the wrecking of almost any large dam is so appalling that no chances whatever should be taken about its ability to resist any conceivable destructive force short of the opening of an earthquake fault beneath the dam (and even this can be guarded against by the horizontally arched dam with extra breadth of base and a well puddled back-fill.

On reflection it must be regarded as rather stupid to apply, and to rest content with, a factor of safety of 2 against the force of gravity and a factor of from 6 to perhaps 20, against the crushing of ordinary masonry and meanwhile ignore the cause that probably led to the failure at Austin, Pa., and that at Austin, Tex., namely, *the penetration of water-pressure into and underneath the mass of the dam, together with its secondary effect in lessening the stability of the mass against sliding.*

For a long time past when computing a stress diagram I have not ventured to reckon on an amount of uplift smaller than that so obtained by assuming that the water-pressure penetrates the pores of the masonry and penetrates the incipient horizontal crack between the masonry and the bedrock, and particularly that it penetrates the seams between the layers of a stratified bedrock, over the entire area of the base to the extent of the full static water-pressure at the upstream face of the dam, and the further assumption that this pressure averages tapering off at a uniform rate to a zero pressure at the downstream face or toe of the dam.

From what I have seen at the two Austin dams I shall in the future be inclined to impose the further criterion of ability to withstand the full static pressure of the water from the upstream side penetrating with undiminished force to nearly the downstream face or to the toe of the dam.

With the loosely-adherent, stratified bedrock at both Austins, it is easy to believe that this condition could possibly prevail.

It surely is reasonable to expect the full water-pressure will penetrate some distance beneath the dam and the rate at which this pressure will diminish as we proceed downstream beneath

the dam, is obviously merely a matter of relative area of inlet and outlet and size of crack and the tendency of the application of the resultant pressure will be to cause the seams to become tighter nearer the toe, so that the uplift pressure will penetrate farther and with greater force than a force varying uniformly to zero at the toe. Natural conditions in the bedrock seams may readily be conceived of which will allow the uplift pressure to travel almost the entire width of the dam with but slightly diminished force.

Compute the position and direction of the resultant for either of these dams on this hypothesis, and see just what resistance against sliding you have left; particularly in a case where the base of the dam is not deeply intrenched in the bedrock, or where a shelly bedrock has been ripped off layer by layer, as probably occurred at Austin, Tex., from the enormous force and velocity of the high flood pouring over the dam and its "back-roll."

It is not *abrasion* or *scour* of this downstream rock that is to be feared so much as that stratum after stratum of rock will be torn off by the water-pressure generated by the impact of the downpour against some convenient crack or seam, whereby a force like that in an enormous hydrostatic press will be generated within the seam and lift off the overlying rock, which has but little more than half the weight under water that it has in air.

Regarding penetration of water-pressure within the mass of a dam, the writer has for ten years past been looking for an absolutely impervious dam and has never found but one, and that was an arch dam in the west where chemical action may have played some part in the tightening. You can find plenty of evidence near at hand to illustrate the penetration of water through a dam, for example in the admirable structures in the Croton watershed, on the Boston Water-Works, in the large dam at Boonton, N. J., and elsewhere. Last summer on inspecting the monumental water-works dams in Wales and at Lake Thirlmere in England I found similar leakage and water marks.

We must always expect percolation and the consequent development of uplift pressure, particularly at the plane where the work of one day joins that of another.

In such a penetration of uplift pressure within the mass of a dam subjected to a great flood before the concrete had time to develop tensile strength, I found the most reasonable explanation for the failure in the Montgomery dam. Indeed, in many cases, I am led to believe that the tensile strength of the concrete, which our computations ignore, provides the only safety against an uplift pressure which common methods of computation also ignore.

The fairly regular lengths into which the dam at Austin, Pa., was broken by nearly vertical cracks emphasize the fact that all long straight concrete dams tend to develop vertical shrinkage cracks, somewhere from 50 to 75 ft. apart, and that it is a good practice to predetermine the position and shape of these cracks by building shrinkage joints into the work, and to key the two sides of this shrinkage joint together by a series of shallow vertical tongues and grooves, such as can be obtained at trivial expense by standing 2-in. or 3-in. plank vertically against end-forms placed about 50 ft. apart, which when removed leave a groove into which the concrete of the adjoining section runs and forms a tongue and water-stop.

Several of the broken end surfaces at the Austin, Pa., dam are seen to be darkly discolored, showing that the water had been seeping through cracks at these points prior to the final rupture.

Lest this letter become too long I will close after suggesting consideration by our text book writers of the modification of stresses in a dam that may be produced in a northern climate when the downstream face becomes cooled to a temperature of zero while the center of the mass remains at about 50° and also suggest consideration of the internal uplift pressure that may be caused locally when water percolating through a broad horizontal seam of the dam has its outlet choked by frost.

Ice-pressure did not enter into the failure of the two Austin dams or that of the Montgomery dam; and so I will now merely mention that we have no positive knowledge as to how great this pressure may become. We may be sure that it can be enormous and that an allowance of from 10 to 25 tons per lineal foot of dam is none too great in a northern latitude.

Great boulders pushed up on the shore of northern lakes give evidence of this slow, powerful outward motion of the ice sheet caused by shrinkage cracks, formed in the ice by contraction due to the cooler temperature of the night, becoming filled with ice so that the outer edge of the sheet tends to push outward under the expansion of its top surface by the warmer atmosphere of the following day.

Lack of precise data upon the intensity of these ice pressures makes all the more important some words of caution in the text books concerning it and a full discussion of the conditions that produce it and its possible magnitude under various conditions.

The Collision Between the White Star Steamship "Olympic" and the Cruiser "Hawke."

The reports of the strange collision between the great White Star Steamship "Olympic," the largest vessel afloat, and the British cruiser "Hawke," given in the English engineering journals, add little of definite statement to what has already been published in the cable despatches. It will evidently require official investigation to determine the cause of this apparently easily preventable accident.

We reproduce from London "Engineering" the accompanying views showing the crushed bow of the cruiser and the gaping rent made in the hull of the "Olympic." The latter vessel was steaming at about 15 knots speed and the cruiser on a nearly parallel course. The cruiser was being left astern by the merchant vessel when by a sudden change in the cruiser's course she lunged toward the "Olympic" and struck her a glancing blow at a point about 90 ft. forward of the rudder post. The triangular gap made by the "Hawke's" bow in the "Olympic" is about 10 ft. wide at the top and nearly 20 ft. deep. "Engineering" states that the stem casting of the "Hawke," weighing upwards of 20 tons, has entirely disappeared. The "Olympic" is now undergoing repairs at the yards of her builders, Messrs. Harland & Wolff, Belfast, Ireland.

Fig. 1. The Damaged Bow of the British Cruiser "Hawke."

Fig. 2. View of the Rent Torn in the Side of the "Olympic."

Pseudo Economies in Large Industrial Organizations.

By HART VANCE.*

Economy is, of course, the only object that the modern E-Pluribus-Unum corporation has as an excuse for its being; and the justification of its continuance depends wholly on the soundness of its practice in respect of economy. It is undeniable, too, that (in relation to its constituent companies at least) the so-called "trust" has developed many of the highest conceptions of economy ever adopted in commercial enterprise. Really, though perhaps without distinct purpose, it has done more: Not only is the recognition of a common interest as superior to any advantage attainable in competition, an unquestionable advance in commercial wisdom, but this advance affords the more intelligent organizer glimpses at least of the still greater scope of his own true interest. He perceives that market-conservation and thence a genuine regard for the interests of customers, immediate and ultimate, are imperatively requisite. He discerns that it is at least very desirable to create some interest in the success of his undertaking on the part of all whose labor or skill it would exploit. He remotely begins to realize that there is an absolutely universal community of interest in every real betterment.

Hence the organic scheme of the more modern of the great corporations approximates remarkably those ethical findings, which, though of paramount significance, have hitherto been exclusively ideal. The supposed masters of practicality, that is, have found it worth while to formulate for eminently practical application, principles which the distinctively "practical man" has been wont to sweep into the waste-basket of his mind as "Utopian!"

Nevertheless, it has become quite evident that there is something wrong in the resulting organizations. This is attested not only by an insistent popular imputation, but by a radical readjustment in June of views emphatically expressed in April, by the most authoritative official spokesman of the corporations.

The consummate industrial system has not ensued. The identity of "financial genius" with a faculty for making the most of human agencies, has not been established. Public interest has become inquisitorial, and there are signs of approach on the part of the "captains of industry" to a conclusion that candid cooperation in a thorough inquiry will be their best course. That

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is, they recognize public interest as possibly the most valid and certainly the most momentous of those interests which they have found it wise to enlist and subserve in the prosecution of their enterprises.

In such premises the matter to be presented in this article may have a larger significance than the title makes apparent. It is taken from a notebook recording intimate observations, through a long period, of the actual work of forces organized under a typical corporation of the first magnitude. The specific title of the article comes from an impression produced by the observations referred to, that many of the greatest and most wasteful expenses of a large organization might very properly be combined into one item, and charged as the cost of "Pseudo-economies."

It happens that the instances given are taken exclusively from the experiences of draftsmen. But their significance is wider, for two reasons: First, draftsmen (at least in the case of the industry under observation) do probably more than any other employees toward determining the final quality of the product. Second, the instances themselves make it clear that the errors criticized are central rather than peripheral; that is, they originate in the "heads," not in the "hands" of the great corporation. It is therefore probable that practically the same conditions exist throughout the system which these "heads" control.

It is to be noted also that no one of the instances cited is affected by personal peculiarities or individual bad judgment. In every case the policy illustrated had been ratified by the higher authorities, either directly (by extension of the same policy to other offices) or otherwise (as by the continued advancement of the author of the policy).

Some Penny-Saving Practices.

The cases where thrift is most obviously spurious are petty, but not proportionately inexpensive. To take first the simplest case: The company whose work was specially observed uses in its drawing room an ink of varying but always inferior quality, in buying which probably 15% or 20% of what the best ink would cost is "saved." Estimates made during particularly bad spells of this cheap ink indicate that its actual ultimate cost is from $100 to $125 per bottle.

Innumerable fads run their course in the drawing rooms, and especially afflict the detailers. They originate usually in inspirations of the chief, who is not a draftsman, and are characteristic of the functionary anxious to do his full duty in directing labor which he could not perform. One of the most persistent of these has taken shape in the general instruction that the first consideration of the draftsman in making shop-details shall always be the convenience of the shop. Accordingly it is required that the rivet-spacing on every flange angle shall be so arranged that one board may serve as the template for both "legs." This frequently results in a saving of 50 cts. in the shop at an expense of $10 or $15 in the office, to say nothing of botchy detail.

The windows of one drawing-room give over an unpaved Chicago street, where in dry weather the dust is 3 or 4 ins. deep and has an upward aerial range of not less than 20 ft., for at that height I have seen it pouring over the lowered upper sash upon the drawing-boards of the second floor. Repeated requests have been made by the sufferers that this dust be sprinkled into comparatively harmless mud, but only once, when the assistant manager happened to be in charge, has such a request been granted. The manager, a very strict economist, does not see the sense of expending labor paid for by the company to secure a mere luxury for employees that have an easy time of it anyhow.

Such blunders, all of which impair the draftsman's efficiency, originate in the shortwittedness of mischosen local "heads." But they also indicate deficiency somewhere above these heads, and thus suggest a fatal fallibility in the controlling mind of the organization.

No glimmer of the financial genius that (presumably) blazes in the central councils of this great industry seems to reach the outskirts of its immense system. I have repeatedly worked through day after day in a drawing-room where the temperature ranged between 90° and 104° F., but no intelligence in authority has discovered what an excellent investment might be made in half-a-dozen electric fans. Yet, during the excessive heat, the product of the drafting force was reduced to 50% of normal.

The Hurry Craze.

The great drawing-room specialty, rapidity in production, is of course the principal subject brought into consideration by instances noted exclusively among draftsmen. It has developed a sort of speed-mania among the powers that be, and in fact it is a most expensive farce. "Get the work out!" is a virtual war-cry adopted by its practitioners; and when it is out it usually is *out* in more than one sense.

The process generally is about as follows:

The first production of sheets is "rushed," and the draftsmen excelling in this are credited with speed and marked for advancement. Then, the rush being over, the actual making of the drawings begins, and they are put in more or less available shape by the checkers. This is tedious and the corrections are many, but all the work at all passable is passed, though it be obviously not the best. Often disapproval on the part of the customer follows and the details are practically to be made over, but the detailer retains his original credit, and almost always his drawings, if not actually discarded, retain numerous ill effects of the original bungling haste that brought him that credit.

The grounds for condemnation of this system are numerous. It brings about the promotion of incompetent and unfit men, and results in the juggling of work to retain position, improper shifting of difficulties to the shop, resistance to honest and open corrective processes, and the rise and incalculable detriment of the "dirty-worker." It utterly falsifies, that is, the standards of efficiency and merit.

Possibly the most preposterous development of the speed-mania is a quasi-punitive rule: that when two connecting pieces are detailed by different draftsmen, and the provisions for connection do not coincide, that piece which was finished latest shall be changed to fit the other, irrespective of the comparative merit of the details. That means virtually, of course, that the draftsman who takes time to do good work must botch it after all, in order to connect it with that of the draftsman who only takes time to make a botch.

A year or two ago I had the detailing of some large bins appertaining to a big smelting plant. Certain columns had been specially designed to support these bins in addition to their share of the main structure. I made layouts for the requisite connections, and they were turned over to the draftsman who was to detail the special columns, but he proved to be a "transient" and did not finish the job. When my bins were checked, the column-details could not be found, and it was supposed they had not been completed. Some time afterwards I made further inquiry, and it was then ascertained that the columns had been not only detailed but fabricated. No connections for the bins had been provided, however. Neither detailer nor checker had discovered the necessity for them. Consequently I was obliged to make an additional sheet and instead of twelve identical beams requiring one picture, to draw twelve different beams, with twelve variously preposterous connections devised to fit the random spacing of the shop-rivets in the columns that it would be necessary to cut out. At least the checker in this case—"new" at the time—had been accredited with dispatch.

Another item of my own experience was in certain respects worse: I made the shop drawings of some rather elaborate hoppers. The supporting girders were detailed by a draftsman independent of my direction, but I supplied layouts for the hopper connections. These girders were simple, and the details had been finished, checked and sent to the shop, when my drawings were checked. Reference to the girders then showed that the connecting stiffeners had been reversed in position. This was an indefensible error, but both the checker and his squad-foreman insisted that, as the girders were "out" first, the hoppers should be remodeled. It required strenuous appeal to prevent this idiocy.

Probably the most expensive consequences of the delusion that hustling constitutes dispatch is the practice of plunging prematurely into details. The cost of shop-drawings made from undigested design is usually somewhat worse than a dead loss, for almost invariably an attempt is made to render these drawings available, and thus, if they be eventually discarded, the cost of the attempt is added to the first loss, while, if the conclusion be reached to use them, it is always a clear case of accepting what under normal conditions would be rejected as "rotten."

Inefficient Utilization of Human Resources.

An office employing from fifty to one hundred draftsmen suddenly lost a large number of them. Such a reduction was not indeed unusual, for the force varied continually with the amount and urgency of the work in hand; but the present defection not only occurred when the office was full of business, but deprived it of many of its oldest and most valued retainers. The engineer in charge, "on the carpet" in consequence of the happening, pleaded that his men had been enticed away with offers of much higher compensation, but that the rush of work on account of which a certain railway company had been compelled to secure them would be sure to end with the summer *and then he would be able to get them back at smaller salaries than he had paid before.* Evidently his argument was considered valid, as he has been put in charge of a more important office. It may be noted, too—not without relevance I think—that at the time of his promotion there were in the employment of the office he left only six of the hundred or more draftsmen who had entered it with him seven years before, while not less than a thousand had come and gone in the meantime.

Just here I am reminded antithetically of a long-ago experience of my own. I was in charge of the U. S. survey of Red River, and an estimate of $50,000 had been cut down to $35,000. Not having followed the custom of anticipating such reductions by judiciously augmenting the estimate, I found my official course especially problematic because failure to make the run (from Fulton, Ark., to Shreveport, La.) in the one season would entail complete reorganization to complete it next year, and so an additional cost of $15,000 to $20,000. Under the circumstances I made extraordinary efforts, first asking that the appropriation be made immediately available in order that I might take full advantage of the limited "season." This request being granted, I followed it up with another for authority to increase the salaries of my subordinates 20%. To this the office of the Chief of Engineers objected. It couldn't see how an increase in expenditure would remedy the shortage of 30% in my appropriation, which I had already pointed out; but I could. I was asked to explain and did so. The offer of exceptional remuneration, I reported, would enable me not only to take my pick of the young engineers seeking employment in the River and Harbor service and to hold them throughout the work, in spite of the region's unhealthiness, but to exact the extraordinary exertion on the part of each and all of them that would be requisite to complete the undertaking within a given time. This authority too was granted, and I completed my $50,000 worth of survey for $33,500—because every man of my force knew that he would get the full value of the work required of him, both in money and in personal consideration.

This is an assurance that, according to my observation, is entirely denied the actual workers—the actual producers—among the employees of the so-called trusts. The alleged great brains of these organizations seem to have missed entirely the fact that such an assurance vouch-

safed their employees would be incomparably the best-paying investment they could make.

The instances adduced here might be reinforced with hundreds of like import. The careful observer has, indeed, continual evidence that those projecting stupendous organizations for the development of great natural resources have practically overlooked the greatest of all, human character. Yet upon their proficiency in the development of this resource must depend their success with others. It is not out of order to remind these projectors that a great industry is primarily a great composition of human efficiencies, and that mastery of the principles of such composition is indispensable to their success. But, apparently, they are quite unfamiliar with these principles; the many gross errors which I myself have witnessed furnish cumulative proof of this fact.

I know of the gospels of efficiency just now gaining vogue—"the latest revisions of the rules for squeezing blood out of a turnip" they have been not inaptly termed. And I am quite familiar with the transcendent pretensions to "administrative genius" on the part of nominal "Heads," and with the argument that executive ability consists rather in a talent for exploiting the efficiencies of others than in the possession of any specific efficiency. This latter argument has been exhaustively urged in justification of the "princely" or "fabulous" salaries advertised as attaching to those "Heads," for example one young man whose exploits were conducted at Monte Carlo, or another who has devoted himself to daring sociological experiments. Nevertheless the proof to which I have referred continues.

To begin again with the seemingly trivial, but not the less significant: The pay of the larger forces of men with which I have been connected is usually withheld four or five days after the end of the period for which it is reckoned. I supposed for a long time that this was for the convenience of the accountants but, coming upon reasons to doubt my assumption, made inquiry. "Why, if we once let 'em get away with nothing coming to 'em," the chief from whom I sought enlightenment told me, "We wouldn't have half of 'em back next morning."

This explanation, it is true, affords a certain alternative of interpretation, but there is little choice between the two renderings: Either the corporation has no confidence in having taken adequate measures to attach "its men" to its service, or the men are regarded as of too low a grade to be amenable to any moral obligation.

In reality the necessity for all sorts of diplomacy in binding men to the service is clearly recognized. One obnoxious evidence of this is the prevailing encouragement of matrimony. No other employee is so tractable as the married man. And his tractability is of course enhanced by the economy which reduces his means of livelihood to a minimum.

The sheer truth is that a practice of deliberately *imposing disabilities* in order to hold men, has been definitely adopted; and the gross incompatibility of such a policy with true cultivation of efficiency has not been perceived.

It is undoubtedly held and sometimes unhesitatingly argued that the desperate exertions of a man under constant stress of the necessity of making a living for those dependent upon him gives his work its highest economic value. The surer play of the unencumbered faculties of one not thus harassed, is but vaguely appreciated, if at all.

The policy of securing executives unhandicapped by any consideration superior to the objects of organization is explicitly pursued. Talking not long ago with a brilliant young acquaintance, already manager of one of the big plants of a big corporation and destined to be one of its "magnates," I asked what had become of E., an associate of ours in "the service" a few years ago. "Dropped out," he replied, and then added, after a pause: "The trouble with E. was, Vance, that he was too conscientious."

The fact is scarcely dissembled that certain attributes which are conventionally esteemed the highest constituents of manliness disqualify one for "responsible" positions, especially for positions whose duties involve quasi-commercial dealings or discretionary control of operatives. In the latter case a somewhat curious consequence frequently appears in the details of organization of employees of that class to which my observations have been in the main restricted: High professional attainments almost invariably induce to a decisive degree just that highmindedness which is considered incompatible with the crass "economy" under consideration. As a rule, therefore, the technical expert is ineligible to the actual direction of a force of men. And yet his proficiency cannot be dispensed with in conducting the work. Hence (in instances enough within my knowledge to warrant at least the imputation of a practice), such proficients have been secured in strictly subordinate positions to serve as coaches for those who had been put in charge on grounds that had no reference to professional qualifications.

Men of very positive ability of course cannot be retained in such a relation. I have known of several cases in which the subordinate was so manifestly superior not only to his immediate "superior" but to the Chief so-called Engineer, that recognition of the anomaly by the employees in general could not be prevented, and it was necessary to get rid of him. Extraordinary measures are resorted to, however, to make the arrangement feasible. Part of such efforts is the common formula of disparagement: "I can hire all the technical skill I need, at laborer's wages. What I am looking for and am willing to pay big money for is the man who can turn the work out like I want it." Individual disparagement, too, is not refrained from, when there is a danger of losing such a professional coach as I have described.

It may be remarked here, that the work "turned out like I want it" is frequently of a quality so gaged as to render it just reasonably safe under the ordinary "commercial inspection," but not such that a true professional man could in any capacity honestly approve it. To quote a description I have heard, "It is just good commercial work without any technical frills."

The great system of industrial economy put into effect by the modern corporation is, I believe, fairly, if not exhaustively, illustrated in the facts and deductions set forth. Always the immediate saving is accounted "profit" and made the first and final consideration; and always as a consequence the men chosen to administer the fundamental ideas of the system, while intensely wary of any avoidable cost of doing a thing in the right way, seem totally without apprehension of the inevitably excessive cost of doing a thing in the wrong way. This is especially exemplified in the greatest and most expensive of their pseudo-economies—that practiced in the dealings of the corporation with its employees. Some of the facts not realized in this connection may be specified:

1. The cheapest man—like the cheapest ink—may be eventually the least profitable.

2. An employee who can be retained under degrading or unfair conditions is essentially of a debased efficiency.

3. A preposterous prodigality in the emolument of high-titled incompetents cannot be compensated by a paltry retrenchment of the proper remuneration of those who do the actual work.

The absurd mis-relating of protege and producer has its most pernicious effect when it is aped in the sub-organizations. A man who submits to the indignity of subordination to an inferior—especially an inferior paid exorbitantly for work done by the underpaid subordinate himself—is not likely either to regard his employer's interest very cordially or to have about him the self-respect that would prompt him to render full value in the service he has undertaken. He is very likely to make quite sure that he deducts from his service at least an equivalent of the consideration he does not receive.

The old-fashioned assets, confidence and goodwill are, of course, not counted when "economy" is made to involve a policy of contempt for "sentimental considerations" in dealing with those human factors which after all will finally determine the real success or failure of any industrial undertaking. But indications justify the prediction that the value of these assets will be enormously enhanced in the markets of the near future, and that the great corporations will be the most eager bidders.

A standing offer of special rewards for "the faithful" among employees (the definition of fidelity being expressly reserved to the officers of the corporation and always strictly confidential), will not recoup these wanting resources. Nor will they be restored through any assurance of merely pecuniary consideration.

In fact none of the schemes in effect will make up for the loss they bring about in moral reduction of the employee's capacity; and, while some of the projects yet untried may produce more work, none of them will produce better workmen.

The worst of the abuses and fatuities already obnoxious to the public conscience as characteristics of the "Trust," has been a systematic perversion of the moral sense of those constituting the immense industrial forces. And on no subject, perhaps, has this evil been more prolific than in regard to the grounds of advancement. Men finding it impracticable to better themselves through normal merit or proof of specific qualifications, adopt—if they advance at all—the course determined by existing conditions, and that is a veritable "hold-up" game. Excellence in their work when it does not materially promote their interests becomes a subject of minor consideration, and the attention that should be given to improvement in that respect, is concentrated in a shrewd watching for opportunities of enforcing a demand for better pay. The situation is quite explicitly recognized among them. "How much did you hold the Old Man up for?" is an inquiry not infrequently heard.

Men who reach authority by such a course certainly have not qualified themselves to make the best of the men under them, or in any sense to develop the highest efficiency of the organizations which they direct. The actual result with them is a manifest failure to realize that the employment of freemen is more profitable than the possession of slaves; that the service of a man too manly to sneak for a living are worth more than those of the spy and the tale-monger; and that a gentleman is always of greater efficiency than a boor.

The cardinal truth, which neither they nor their superiors comprehend is that the efficiency of any organization is dependent in the highest degree upon its morale; and that its morale is the resultant of personal forces and ethical relations, subject to just as definite laws and determinable with just as great precision as the stresses in a steel structure.

The determination and adjustment of these forces and relations are functions of the Moral Engineer. The Moral Engineer out-ranks the Mechanical Engineer and the Civil Engineer. He is of the order of great generals in respect to ability. He is incomparably the superior of the greatest military genius in respect to the field of his operations and the value of his achievements. The great corporations should consult him.

At the Mine-Rescue Exhibit, to be held at Pittsburgh, Pa., Oct. 30-31, more than 50 teams from as many different mines have signified their intention of entering the life-saving contest. While most of the teams are from mines in Pennsylvania, the States of West Virginia, Maryland, Illinois, Ohio, Kentucky, Alabama and even New Mexico and Washington are represented.

The Value of Gypsum Production in the United States for 1910 was $6,574,478, according to a report by Mr. E. F. Burchard, of the U. S. Geological Survey. It is reported that 2,375,394 short tons were mined. New York was the largest producer, with Iowa and Michigan following. The bulk produced was manufactured into plaster of paris, plaster stucco, plaster boards, etc. The value of the imported gypsum was only 3% of the domestic production.

FIELD AND OFFICE

Discharge-Increasing Lip for the Blow-Off Pipe of a Dam.

By DONALD F. McLEOD.*

A new water-works dam for the City of Ithaca, N. Y., near Potters Falls on Six Mile Creek, is now under construction and nearly completed. Among the details of construction of one of the blow-off pipes of this dam is a device for increasing the discharge, illustrated by the photographs and sketches given herewith.

It is a well known fact in hydraulics that where the entrance to a discharging tube has

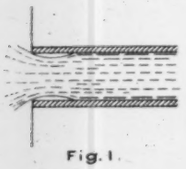


Fig. 1.

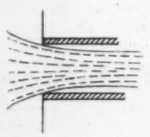


Fig. 2.

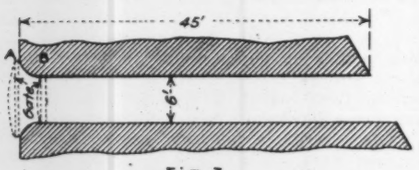


Fig. 3.

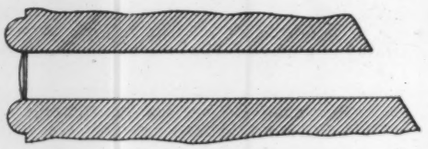


Fig. 4.

square edges the diameter of the stream contracts a short distance downstream, somewhat as shown in the sketch Fig. 1 if the length of the tube be greater than about 2½ times its diameter, or somewhat as shown in Fig. 2 for a lesser length. The bore of the contracted stream is such that the discharge of the tube is about 80% of that theoretically possible from the given head and area of orifice. As it has been found by various experimenters that the discharge could be increased to nearly its theoretical value by rounding the orifice of the tube, it seemed worth while to the writer to try this rounding process in the case of the blow-off pipe above mentioned, which is 6 ft. in diameter and 45 ft. long. The rounding could not well be done as in Fig. 3, because if the sluice gate were placed flush with the face of the dam it would be unnecessarily large, while if the sluice gate were placed at B a special chamber would have to be constructed in the masonry, for a sliding gate of the usual type.

An attempt was, therefore, made to solve the problem by building a rounded projection of concrete on the face of the dam as shown in Fig. 4. The concrete lip was intended to contain some light steel reinforcement, and to be built monolithic with the concrete of the dam except for one section, which was to be bolted into place so as to afford more room for placing the gate frame. As actually constructed, however, the concrete lip was built in place all in one piece, after the concrete of the dam had set, and was connected to said concrete by heavier steel reinforcement than that originally designed.

The sluice gate enters the concrete lip in a slot, at an angle of 34° with the vertical. When the gate is fully opened the only break in the continuity of the rounded entrance to the blow-off pipe is the clearance between the gate and the walls of the slot.

*City Engineer, Ithaca, N. Y.

FIG. 5. FORMS FOR LIP OF 6-FT. BLOW-OFF PIPE.

Provision for Openings in Reinforced-Concrete Slabs.

By EDWARD GODFREY,* M. Am. Soc. C. E.

When a carpenter in laying joists wishes to leave an opening, as for stairways or ventilators, he will put in a header to which the shortened joists are attached. But he also doubles up the joists which receive this header. Reinforced-concrete builders have a far from commendable or correct standard for similar conditions, which is based on analogy with the carpenter's practice in fitting joists, but an essential and vital point in the analogy is overlooked. The standard in question is best known by the sketch in Fig. 1, which represents a rectangular floor-slab supported on four sides and reinforced with rods in one direction. Openings are left against the wall, and the figure shows one way of taking care of these openings in the matter of placing the rods. It makes a neat looking job to place the reinforcing rods exactly parallel and to clip off all rods where they would otherwise pass through the openings, and the cross rods along these openings stand for headers in the carpenter's framing plan. But looks count for little where strength is ignored, and all of this beauty is soon covered up with concrete. While the carpenter's "header" is present, the doubling up of his side joists is absent.

A vastly more efficient way to lay the rods, though less artistic in appearance, is shown in Fig. 2. Here rods run from support to support and get a bearing on the wall. They get their full grip in the concrete and reinforce the slab so that it is capable of taking more shear. Some of them may be curved up and continued beyond the support, so that they are thus rendered capable of taking shear in themselves. The cross rods are not headers but serve to reinforce

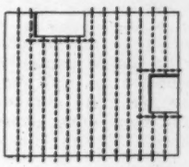


Fig. 1. Wrong Method.

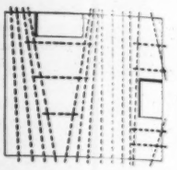


Fig. 2. Right Method.

Methods of Placing Reinforcement Around Openings in Slab.

the slab locally. Expanded metal may be used in these triangular spaces. It is, of course, true that this floor is not as strong as one without the openings, but it is greatly superior to the floor shown in Fig. 1.

Another poor method of taking care of floor openings is to curve the rods horizontally with double curves to dodge the openings. The reinforcing rods should show straight in plan or nearly so, as a curved rod will tend to rotate.

*Monongahela Bank Bldg., Pittsburgh, Pa.

A Mechanical Shaker for Fineness Tests of Cement.

By A. D. GATES.*

A convenient and rapid mechanical shaker for cement-testing sieves designed by the writer is being used in making fineness tests on cement for the Panama Canal. It is shown by the drawing herewith.

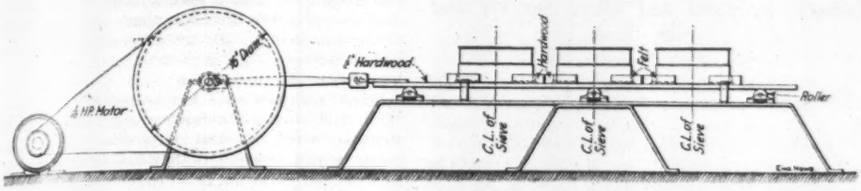
The machine is composed of a wooden board resting on rollers, which are attached to a steel frame. The board is reciprocated by a pitman attached to a 16-in. pulley on a 1-in. crankshaft. The pulley is driven by a belt from a small motor. The board, on which the sieves and collecting pans are placed, carries two blocks of wood for each sieve; these are cut to 4½-in. radius, or larger than that of the sieves, and are set ¼-in. off center, so that when the apparatus is in operation the sieve is shaken well and at the same time is rotated. Around the outside of each collecting pan is attached a piece of felt, so that impact with the board may be deadened.

The reciprocating part has a stroke of 2 ins. Its speed is 200 strokes per minute. Sieves of standard size are used.

Three 50-gram samples of cement are carefully weighed and placed in the 200 sieves, set on the board, and the machine is run for 5 mins., whereupon the cement is removed from the collecting pans; the sieves are replaced and the shaking process continued for 6 mins. longer, when the cement is again removed from the collecting pans; the sieves are again replaced and shaken for 1-min. periods, until less than 0.1% ceases to pass. After the test on the 200 sieve has been completed, the residue is placed on the 100 sieve and treated in the same manner, except

Fig. 6. Concrete Entrance Lip After Removal of Forms.

*Bureau of Standards testing laboratory, Northampton, Pa.



MECHANICAL SIEVE SHAKER FOR FINENESS TESTS OF CEMENT.

that it is only shaken for 3 mins., then for 1-min. periods.

The machine is a great time saver. One man can make 75 complete fineness tests in a day by using the machine, while it would require six men to make the same number of tests by the hand method. It requires about 15 mins. to make the test on the 200 sieve, and 5 mins. on the 100 sieve, making a total of 20 mins. per set of samples, or an average of 6⅔ mins. per sample. Further, the results obtained with the machine are more uniform than those obtained with hand shaking.

A New Method of Dragging a Channel for High Spots.

By EDWARD W. WENDELL.*

The method employed to drag Contract No. 1 of the New York State Barge Canal for high spots possesses, I believe, advantages not embodied in any other method. No instruments are necessary to observe the location of the drag at the time a high spot is reached by the sweep. The uncertainty of buoy location of high spots is done away with. By this I mean that even if the buoy is thrown out accurately, which is nearly impossible, a passing tug, with or without scows, will displace it.

The sketch in connection with this description will make the method plain. The boat is the ordinary platform box-type scow, equipped with a boiler and an ordinary hoisting engine. The engine is geared down to a line of shafting, upon whose opposite ends are keyed a pair of horizontal nigger heads. The boiler, engine, etc., are so housed over as to leave a clear space outside the housing upon the deck, with the nigger heads projecting through the housing, as shown. I may mention here that when the stream flows with a strong current but one nigger head would be necessary. Over the end of the boat on which the boiler is situated, a 30-ft. rail is hung by two chains passing over grooved pulleys. The reason chains are used in place of cables is because the U-rod can be slipped through a link and then through the holes drilled for the rod ends in the base of the rail and the nuts screwed on. Also, the rail can be set accurately by slipping the link of the chain in a slotted plate, so that the next link acts as a shoulder against the plate. This is mentioned in detail because it is essential, where necessary to change the rail elevation very frequently due to change in water surface, to be able to do it quickly and accurately. With this arrangement, the rail may be shifted to agree with a signaled change in less than a minute. On the same end of the boat as the rail is a reel with a 1,000-ft. tag line, graduated every 10 ft. and marked with a brass tag. The idea of having the rail and tag line on the same end of the boat, and both of these at the boiler end, is because when a spot is struck the tag line can be pulled up taut and the distance to the rail read accurately. Moreover, the fireman, besides tending the boiler, can operate the tag line, thus saving a man.

In the absence of a strong current, two continuous lines are used, each one passing over a nigger head, as shown. The lines are fastened above and below the range being dragged, as shown in the sketch, and the boat does not vary perceptibly from its course during the trip across. The rail gives an overlap of 5 ft. on each preceding course, so that every space is covered. The downstream lines need be shifted only every third or fourth trip, but the upstream line is shifted every trip. The side of the housing is used as a sighting line, and a 5-ft. and 10-ft. 4-in. iron-shod range board is used on the range being dragged. The 5-ft. board is placed on the near stake and the 10-ft. board on the far stake. Both boards are painted white.

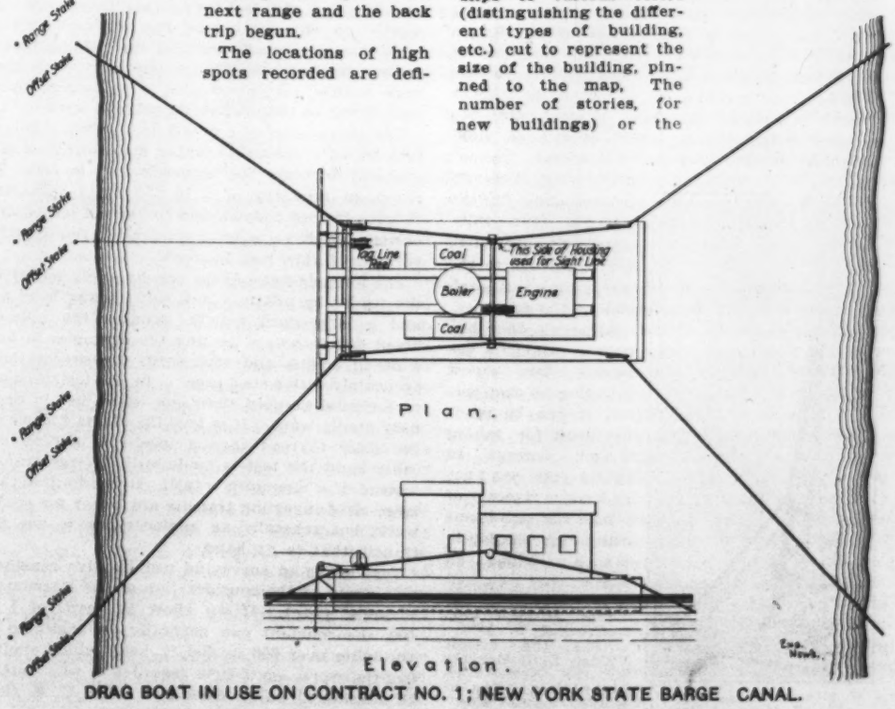
The center line of the channel is carefully staked out on the offset lines on shore every 25 ft. for the entire distance to be dragged. If possible, have these lines on shore parallel to the center line, as it facilitates not only the final drag, but the entire prosecution of the contract. Parallel this first line by another a hundred or so feet from it, these stakes to act as ranges on the normals. Of course, in narrow quarters, the range stakes will have to be placed on the opposite shore to the offset stakes, but it is exceedingly rare that this occurs, and then, as a rule, it is some building such as an icehouse, which causes the inconvenience.

The boat being placed on range, the end of the tag line is placed over the offset stake, and from the list of offsets the center line is known for the range. The gage-man reads the gage and the rail is set by the graduations on the chain. The lines are made fast to iron pins driven in the ground or to conveniently situated trees or stumps. The engine is started and when the toe line is passed the chains leading to the rail are watched. When a high spot is struck it is easily seen, as the slightest elevation will cause a movement of the chain when the rail is hung head down in this manner. The tag line is read and recorded, and during the whole trip the drag does not stop. When the tag-man reads the distance necessary for the opposite toe line the boat is stopped until the upstream line is shifted and the range boards and tag line are moved to the next stake. Then the engine is started, the boat pulled up to the next range and the back trip begun.

The locations of high spots recorded are definitely known, as the range and the distance from the center line are definitely given. This list is given to the dredge runner if soft material has been dredged over this area, or to the drill-boat foreman if rock was located here. Both the dredge and drill boat should work with tag line and ranges at this stage of the work. The points are easily found and removed.

This method of dragging has many advantages. The channel does not have to be buoyed out before beginning to drag. The limits of the channel are definite. The high points are positively located; and if it is desired to know their extent while dragging, the boat can be stopped instantly and held still while the extent of the high area is investigated. It is a most rapid and satisfactory method.

*Assistant Engineer, New York State Barge Canal, in Charge of Contract No. 1; P. O. Box 65, Fort Edward, N. Y.



DRAG BOAT IN USE ON CONTRACT NO. 1; NEW YORK STATE BARGE CANAL.

A Fountain-Pen Attachment for draftsmen's pens, described in a recent issue of the "Scientific American," consists of a cylindrical metal reservoir which can be readily attached by means of a spring clip to the pen handle. Ink from the reservoir flows through a capillary tube which delivers it to the space between the two blades of the pen. The reservoir is about ¼-in. in diameter and a couple of inches long, and the capillary tube has a length of perhaps 3½ ins. It is suggested by the inventor that a number of these reservoirs, ready filled with different colored inks, could be carried conveniently in a pocket case and would be of great convenience for maps and topographical drawings.

Keeping Track of the Distribution of Building operations in the Borough of Manhattan, New York City, will in future be facilitated by a gigantic wall-map on which are stuck pins or wafers indicating every new building and every alteration in progress. This plan was lately originated by the Superintendent of Buildings, Mr. Rudolph P. Miller, M. Am. Soc. C. E., for giving a graphical presentation of the work of the Bureau of Buildings, at the Budget Exhibit, now on. The map for the exhibit shows the building operations for Sept. 15, 1911, but after the close of the exhibit the map will be revised to the later date and is then to be revised and kept up to date at all times, for the continuous guidance and advice of the officials of the Bureau. The map is about 5 ft. high by 25 ft. long, in six sections mounted on compo-board and framed in wood. On Sept. 15 there were, in the Borough of Manhattan, 458 buildings in course of erection, 952 buildings under alteration, and 542 cases of minor alteration or repair in progress. The last mentioned were marked on the map by sticking in black-headed pins. Alterations and new buildings were marked by paper slips of various colors (distinguishing the different types of building, etc.) cut to represent the size of the building, pinned to the map. The number of stories, for new buildings) or the

cost (for alterations) were noted on these slips. The map so marked not only gives at a glance a survey of the distribution of work over the city, and the distribution of different classes of work, but also affords a large amount of detail information. It is expected that the administration of the Bureau can be conducted more effectively with the aid of this map.

A Derrick for Deep-Water Soundings.

By EMILE LOW, M. Am. Soc. C. E.*

The illustrations show a small derrick especially convenient for handling steel sounding rods in deep-water soundings in determining the depth of rock surfaces.

The derrick is erected on a small platform car which runs on a track placed along one side of the deck of a scow. The gage of the track shown in the illustration is 6 ft. The car itself is modeled along the lines of a small railroad sectionmen's car, and measures 7 × 8 ft. in size. The wheels, four in number, are 12 ins. in diameter, with the usual journals. The timbers of the car frame are generally 4 × 6-in. The main shear legs of the derrick are also of 4 × 6-in. stuff, the bracing being somewhat smaller material. The legs are hinged to the bed of the car, so they can be let down flat, or entirely disconnected when necessary. In working position the top overhangs the edge of the scow, which allows free movement for manipulating the sounding rods. To hold the legs in place two light steel guy rods are provided, the bottom ends of which hook into iron eyes, also attached to the car. The back movement of the legs is prevented by two 3 × 4-in. wooden braces, suitably attached. The normal height of the derrick in working order above the deck of the scow is about 17 ft.

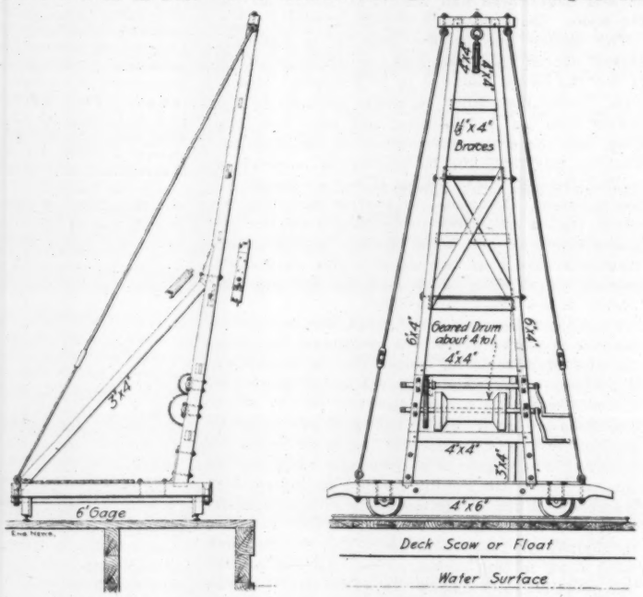


FIG. 1. SIDE AND END ELEVATIONS OF SOUNDING DERRICK.

A geared drum, 4 to 1, is also provided for lowering and raising the sounding rods, for which purpose any good manila or hemp line is used. The sounding rods can be of any length up to 100 ft., and are preferably made up of heavy pipe in about 20-ft. lengths, the various sections being screwed on or off as the pipe is lowered or raised. Any kind of steel point can be used in the bottom length of rod, as judgment may dictate or experience proves.

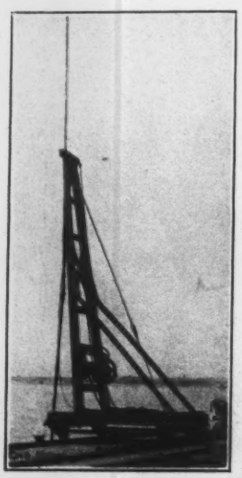


Fig. 2. View of Derrick at Work.

To keep the car from tipping off the track four rail-clamps are needed to secure the car to the track, one at each end of the car.

Although the derrick is primarily designed for rock sounding in deep water, it can be readily used for taking wash borings in sheets of water, lakes, rivers or ponds, the operations being very similar to wash borings on land.†

*606 Ashland Ave., Buffalo, N. Y.

†See the article "Wash Drill Borings on the New York State Barge Canal," Emile Low, Engineering News, Jan. 17, p. 54.

Remarks on Stadia and Allied Surveys and Survey Rods.

By W. NEWBROUGH.*

Most articles on stadia rods and stadia surveys have treated of particular kinds of surveys, and the rods and methods therein mentioned have been adapted to the particular purpose required. It is about as difficult to get a rod or a method of survey suited to all classes of work as it is to get a universal transit. The subsequent remarks, as well as the rod here shown, are the result of twenty years' experience (on nearly all kinds of surveys suitable for stadia) of the writer and his assistants; and while it is not claimed that either the method or the rod recommended is perfect, still both have been thoroughly tested.

We have found that stadia surveys are practicable when an error of 1 in 400 can be allowed. This refers to surveys for filling in details on more accurate work as well as for original surveys. Johnson's "Surveying" gives an average error of many lines of about 1 in 600 or 1 in 700; but these surveys were run more carefully than usually pays, the fact being that they were run mostly on one continuous line of work, where both the instrument men and the rodmen had a chance to learn to become expert. Also they were mostly on Government work, where more time could be taken than on private work.

The above error of 1 in 400 applies when mountain transits are used; larger instruments would probably increase the accuracy to 1 in 500. To reach an accuracy of 1 in 650, it is necessary to have trained rodmen and to use rod levels, and one should have a level to control the vertical vernier, if this last is used.

The foregoing statement can be easily tested by the reader by taking a new self-reading level rod and a large-sized transit, sending the rodman about 400 ft. away, reading the distances to half a dozen points, and afterwards measuring them accurately with a steel tape. In this test, no more care should be used than one would use in ordinary stadia work. It is true the stadia rod would be easier to read than a level-rod, but on the other hand the test is made with a large transit instead of a mountain transit. It is admitted that large-sized inverting transits are better for stadia work, but generally an engineer has to use the transit that is at hand.

Text-books on surveying usually give considerable space to the consideration of the instrument constant (f+c). If we allow an error of 1 in 400, the constant can generally be neglected in all sights over 600 or 700 ft. long, which simplifies the work; or if it is regarded it can usually be considered as an even foot. The U. S. Geological Survey makes special rods which average this and give the distance direct from the center of the instrument. In ordinary work special rods are a nuisance, as generally they can only be used with one instrument.

Fixed stadia-wires that accurately subtend 1 ft. in (100 ÷ the constant) are good. So are adjustable wires. If the latter get out of adjustment (which is seldom) they are easily fixed, and lack of adjustment is almost instantly noticed by the unequal distances of the outer wires from the center wire. Fixed wires that do not accurately subtend 1 ft. in (100 + the constant) are a nuisance, because they either require a special rod or a calculation. The best thing to do with such is to send to the maker and have them changed.

Allowing, then, that an error of 1 in 400 is permissible, we see that we do not need to read the instrument to the nearest minute. One minute will give an error of 1 in 3450, basing it on the tangent of the angle; or, taking half the tangent for the probable error, 1 in 6900. In the same way taking 15′ we find it gives an error of 1 in 460, or 11.5 ft. per mile.

We can of course read the vernier to the nearest 5′, but unfortunately by doing this we do not decrease the subsequent office work of the survey, unless we are fortunate enough to have accurate and expensive protractors or calculating machines. And if we cannot decrease the office work it is easy to read verniers to single minutes as to five. Reading to 15′, if our measurement error and our 15′ error should both be the same way we should practically have an error of about 1 in 225; but by the theory of probabilities the two would probably combine and make our final error about 1 in 430, or some such matter, and this is what actually occurs. Also, reading courses to the nearest 15′ greatly simplifies the office work. Now this can often be done by setting on the nearest 15′ and moving the rodman on line and taking this as the point or station (we are not here considering "shots," which should always be read to the nearest 15′ only). Or we can abandon the vernier and read the needle.

The poor needle, however, has been so condemned in many sections of the country that it seems almost heresy to speak of running a survey by it. Text-books condemn it, the U. S. Land Office has issued commands prohibiting its use, and many surveyors are unsparing in denouncing it. And yet it is a good and useful tool when used aright.

One can run around a section of land (4 miles) and if no local attraction is present (and this is easily ascertained) the needle will close on the starting point within a few feet, provided the chaining is correct. If one has a meridian and knows the declination, the instrument can be set on the magnetic meridian by the needle, or to the nearest degree mark, and the declination turned off on the vernier, and the average difference will be less than 3′, in forty trials.

The needle needs no backsight. Nor does a solar attachment. But the needle gets out of adjustment far less easily than the latter. The needle makes no mistakes in its pointings, but the transitman does by reading angles wrong, and he carries his error forward, while the needle does not.

The needle fails when land is worth a thousand dollars a front foot, but often when land is worth two dollars or ten dollars an acre it is the ideal instrument. It is the thing to use when filling in stadia details on a large survey, in running irrigating canals with the stadia for various State Engineer's Offices, in making reconnoissances, and in doing all work where speed is required and where the expense must be a minimum and moderate accuracy only is demanded.

For rough work, such as finding section corners, ordinary stadia work is too slow, especially where long sights can be obtained. As ordinarily done it requires a set-up, and then a sight, with 1,200 ft. as a maximum; then the rodman waits until the instrument comes to him, and then goes on again. Thus the party is walking only half the time; this objection can be partially obviated by mounting the rodman on a horse.

*Evanston, Wyo.

Such work is usually done with a long steel tape (200 to 500 ft.) and measuring along the ground, a chaining foresight having been taken to a natural object. By this means the instrument and the tape are going along together. As much as 15 miles per day have been run in this manner and every full section corner searched for.

Myself and assistants used the following combination stadia method with equal speed and a saving of one man:

Use the stadia on short sights. Mount the rodman and the instrument man on horses. Give the rodman a pair of field glasses. Send the rodman ahead as far as necessary or advisable. Set the plates of the instrument at zero; set the stadia rod on line; turn 0° 34½′ (or 1° .09′) right or left; again set the rodman on line, he moving as near as he can judge at right angles to the line of sight, having left a pin at the first point; and finally measure the distance between the two points that have been occupied by the rodman. One hundred (or fifty) times this distance is the length of the sight. The main trouble with this method of surveying is to get a rodman who is competent.

For long sights, after trying many markings of stadia rods, we have found the whole feet painted black and white alternately to be about as good as anything. This can be varied by having a couple of the feet, say the fifth and tenth, subdivided. Such a rod is suited only to long sights, but it has the advantage that it is easily made and easily read.

We have tried rods where the feet were marked by figures each a foot long, the subdivisions being marked on these figures by points or bends. They are very good, but the points do not seem to be as plain as diamonds or saw teeth. Their advantage is that in close sights one can see the figures to tell which foot-mark is struck by the wires. For all practical purposes the same result can be attained if certain foot-marks are distinguished by a different design from the rest; if the fifth, seventh, and tenth foot are thus distinguished, the remaining ones on a 14-ft. rod can be read at a glance. This, however, cannot be done if the sight is so short that only 1 to 1½ ft. is subtended by the wires.

We have tried rods that were of the same breadth at top and bottom. We find this unnecessary if the top of the rod is clearly distinguishable, because the upper wire can be set on this and the reading made by the lower wire. Thus the top can be of less width than the bottom, which saves weight and makes the rod much easier to hold in the wind.

We find that it is safer for the instrument man to do all the reading, as we have to pick up rodmen where we can. This prohibits the use of a lower target. The method is also quicker.

Red is not plainly distinguishable from black at long distances.

Owing to the length of spring-wagon boxes, a rod when folded should not be over 7 ft. long. Also it is better to read the full width of the two wires, as the half widths give a check. This should always be done when possible, and this method requires a long rod. All rods should have a case, and this case should fit loosely. If made tight it soon wears out. We generally make a long narrow bag out of canvas, long enough to fold back over the end of the rod so that it can be tied with a string.

When traveling, whether by wagon or by train, it is inconvenient to carry both a stadia and a level-rod; therefore, as far as can be done, one rod should serve for both purposes.

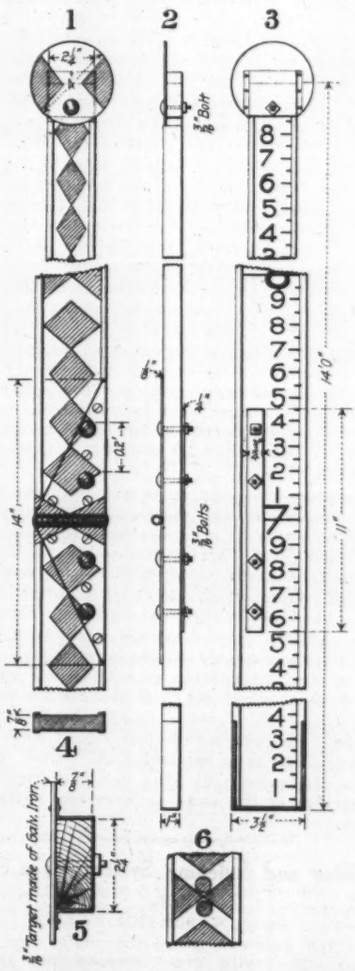
The foregoing are some of the requirements that we have to meet. Other engineers will have different requirements, but in general they will be too numerous to be satisfied by one stadia rod as ordinarily made.

By trying to make the best of things, we have gradually evolved the rod here shown. The points that are claimed for it are the following: (1) It is double, being marked on both sides, and so has double the capacity for use of any rod we have yet seen. (2) It is 14 ft. long and folds to 7 ft., dispensing with the brace end which usually extends beyond the rod when folded. (3) The construction of the joint makes it rigid at all times. (4) By having the 5, 7, 10 and 14-ft. pieces marked by special diagrams, it is as easy to read any foot-mark as if all were marked. (5) For rough work the stadia side can be used as a level-rod, thus obtaining long sights. (6) By turning the rod around, short stadia sights can be taken with speed.

The main claims are (1), (2), (3), above, and holding to these the rod can be graduated in any way the engineer may prefer. The rabbets may be left off and the width so reduced, though at the expense of wear. If left off, then cover the 9, 11, and 13-ft. marks with black sole-leather.

The drawing here shown was taken from a rod now in the office. Several minor changes might be made with advantage.

The rod is 3½ ins. wide; it can be 3 ins. at the bottom if the rabbets are left off. The lower



Folding Stadia and General Survey Rod.

section is this width throughout. The upper part is this width at the bottom and tapers to 2¼ ins. The parts are joined by a strap hinge made as shown, which can be done by any blacksmith. Originally an ordinary strap hinge was used, but this brought the brace rod over the figures on the level side of the rod (sketch 3 in the drawing). The painting is done directly upon the rod, and on the hinge. Through the hinge are bored four holes through which four 3/16-in. bolts are run, with ordinary nuts. Wing nuts can be used if desired, and then clamping can be done with the fingers. It would be better to place the two inside bolts in the white spaces near the hinge. These bolts, and the width of the hinge, serve to distinguish the 7-ft. mark. The bolts pass through an iron rod ¾ × ½ × 11 ins. This will hold the rod perfectly rigid under all circumstances. We first tried two bolts, but found four were better.

The upper end has a target, made of galvanized iron, painted as shown. This has a tubular back, which slips down over the top of the rod. The rabbet is cut off even with the bottom of the target; this gives the target a level seat, and then a 3/16-in. carriage bolt is run through. At first we had no targets, but from some cause or other the paint wore off the top of the rod quickly and made it hard to discern. Frequently the target is left on the rod. It is taken off when shipping, or when it is liable to be damaged.

We first tried targets 5 ins. in diameter, but found they were damaged easier than the 4-in. ones. Also, the 4-in. targets could be carried in the pocket of a survey coat and they proved plenty large enough for our purposes.

The rod is made of dressed pine 1-in. thick. This dressed pine really comes about ⅞ to 15/16-in. thick, so the real rod is a little thinner than shown. The targets were made by a tinsmith.

On the level-rod face is glued a strip of level-rod tape made by the Chicago Steel Tape Co., of Chicago, Ill. This comes in various styles, and any can be chosen that the engineer desires. This tape might be better; the figures wear off quite easily; in fact they rub off. However, it is cheap, costing about 8 cts. a foot, and it can easily be replaced.

The 5 and 10-ft. marks are distinguished as shown in the sketch 6. No claim is made for this particular style of marking, except that it suits our general work. With the construction of rod shown, the engineer can mark it in two styles of stadia if he wishes.

We call this rod a survey rod, as it is both a level and a stadia rod.

Public Land Survey Methods in the Philippine Islands.

By WILLIAM H. DEAN.*

There are many features of the Philippine Land Surveys that will be of interest to the profession generally. Many good points have originated here, and taken as a whole the methods are pretty well representative of the best survey practice. The survey of islands, since islands are miniature continents, gives a great variety of geographic features right within one's limit of vision. There is the sea-coast; the rivers, which because of the heavy rain-fall have a great volume at their mouths but dwindle rapidly in size toward their sources; and the mountain ranges, many of them in sight across the level country. This reduced geographic scale affords a nice view of the application of survey methods to the several land units.

The sea-coast has been triangulated and mapped by the Coast and Geodetic Surveys. From the geographic co-ordinates of the triangulation points a local plane rectangular co-ordinate system is established for each of the smaller important islands, and several such for the larger ones. The surveys that are intermediate to the location of small parcels of land are adjusted in the central office, the man in the field assuming temporary co-ordinates. On the most densely populated land, where much survey work is to be done, preliminary control is obtained by triangulation; the leg of a Coast and Geodetic triangle is commonly used for a base. When necessary to measure a base-line, standard 100-m. Lucas tapes are used, supported, and temperature and pull corrections made from the data sheets furnished for the tape by the United States Bureau of Standards; an error of 1 in 80,000 is allowable.

The traverse that is intermediate between the triangulation and the lot surveys is made by a transit reading to 30″ or 1′, and 50-m. Lucas tapes which are compared frequently with a standard used for that purpose alone; an error of 1 in 5,000 is allowable. The rectangular coordinates of points are used in handling the work. The surveys are azimuth surveys, continuous vernier and vertical angles being recorded with the chained distances; for checks, the stadia reading and needle are recorded. A pair of concrete monuments about 10 ins. square by 30 ins. long, marked B L L M (Bureau of Lands Location Monument) is set, centers being marked on galvanized iron spikes. These are the permanent

*Surveyor, with Bureau of Lands, Manila, P. I.

hangs the edge of the scow, which allows free movement for manipulating the sounding rods. To hold the legs in place two light steel guy rods are provided, the bottom ends of which hook into iron eyes, also attached to the car. The back movement of the legs is prevented by two 3 × 4-in. wooden braces, suitably attached. The normal height of the derrick in working order above the deck of the scow is about 17 ft.

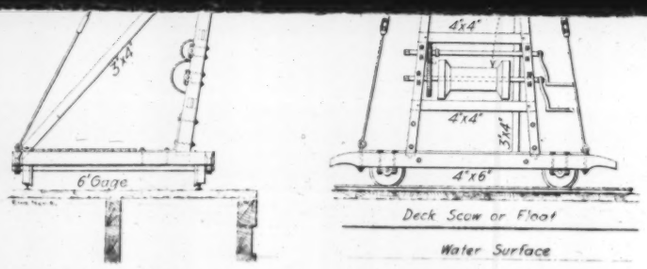


FIG. 1. SIDE AND END ELEVATIONS OF SOUNDING DERRICK.

A geared drum, 4 to 1, is also provided for lowering and raising the sounding rods, for which purpose any good manila or hemp line is used. The sounding rods can be of any length up to 100 ft., and are preferably made up of heavy pipe in about 20-ft. lengths, the various sections being screwed on or off as the pipe is lowered or raised. Any kind of steel point can be used in the bottom length of rod, as judgment may dictate or experience proves.

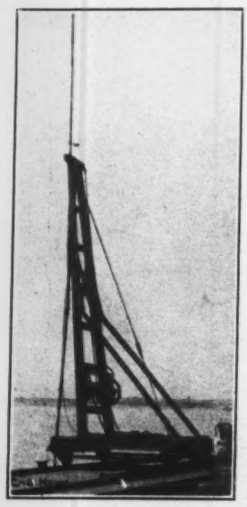


Fig. 2. View of Derrick at Work.

To keep the car from tipping off the track four rail-clamps are needed to secure the car to the track, one at each end of the car.

Although the derrick is primarily designed for rock sounding in deep water, it can be readily used for taking wash borings in sheets of water, lakes, rivers or ponds, the operations being very similar to wash borings on land.†

*606 Ashland Ave., Buffalo, N. Y.

†See the article "Wash Drill Borings on the New York State Barge Canal," Emile Low, Engineering News, Jan. 17, p. 54.

veys. Johnson's "Surveying" gives an average error of many lines of about 1 in 600 or 1 in 700; but these surveys were run more carefully than usually pays, the fact being that they were run mostly on one continuous line of work, where both the instrument men and the rodmen had a chance to learn to become expert. Also they were mostly on Government work, where more time could be taken than on private work.

The above error of 1 in 400 applies when mountain transits are used; larger instruments would probably increase the accuracy to 1 in 500. To reach an accuracy of 1 in 650, it is necessary to have trained rodmen and to use rod levels, and one should have a level to control the vertical vernier, if this last is used.

The foregoing statement can be easily tested by the reader by taking a new self-reading level rod and a large-sized transit, sending the rodman about 400 ft. away, reading the distances to half a dozen points, and afterwards measuring them accurately with a steel tape. In this test, no more care should be used than one would use in ordinary stadia work. It is true the stadia rod would be easier to read than a level-rod, but on the other hand the test is made with a large transit instead of a mountain transit. It is admitted that large-sized inverting transits are better for stadia work, but generally an engineer has to use the transit that is at hand.

Text-books on surveying usually give considerable space to the consideration of the instrument constant (f+c). If we allow an error of 1 in 400, the constant can generally be neglected in all sights over 600 or 700 ft. long, which simplifies the work; or if it is regarded it can usually be considered as an even foot. The U. S. Geo-

*Evanston, Wyo.

what actually occurs. Also, reading courses to the nearest 15' greatly simplifies the office work. Now this can often be done by setting on the nearest 15' and moving the rodman on line and taking this as the point or station (we are not here considering "shots," which should always be read to the nearest 15' only). Or we can abandon the vernier and read the needle.

The poor needle, however, has been so condemned in many sections of the country that it seems almost heresy to speak of running a survey by it. Text-books condemn it, the U. S. Land Office has issued commands prohibiting its use, and many surveyors are unsparing in denouncing it. And yet it is a good and useful tool when used aright.

One can run around a section of land (4 miles) and if no local attraction is present (and this is easily ascertained) the needle will close on the starting point within a few feet, provided the chaining is correct. If one has a meridian and knows the declination, the instrument can be set on the magnetic meridian by the needle, or to the nearest degree mark, and the declination turned off on the vernier, and the average difference will be less than 3', in forty trials.

The needle needs no backsight. Nor does a solar attachment. But the needle gets out of adjustment far less easily than the latter. The needle makes no mistakes in its pointings, but the transitman does by reading angles wrong, and he carries his error forward, while the needle does not.

The needle fails when land is worth a thousand dollars a front foot, but often when land is worth two dollars or ten dollars an acre it is the ideal instrument. It is the thing to use when filling in stadia details on a large survey, in running irrigating canals with the stadia for various State Engineer's Offices, in making reconnoissances, and in doing all work where speed is required and where the expense must be a minimum and moderate accuracy only is demanded.

For rough work, such as finding section corners, ordinary stadia work is too slow, especially where long sights can be obtained. As ordinarily done it requires a set-up, and then a sight, with 1,200 ft. as a maximum; then the rodman waits until the instrument comes to him, and then goes on again. Thus the party is walking only half the time; this objection can be partially obviated by mounting the rodman on a horse.

advantage is that in close sights the rod-men figures to tell which foot-mark is struck by the wires. For all practical purposes the same result can be attained if certain foot-marks are distinguished by a different design from the rest; if the fifth, seventh, and tenth foot are thus distinguished, the remaining ones on a 14-ft. rod can be read at a glance. This, however, cannot be done if the sight is so short that only 1 to 1½ ft. is subtended by the wires.

We have tried rods that were of the same breadth at top and bottom. We find this unnecessary if the top of the rod is clearly distinguishable, because the upper wire can be set on this and the reading made by the lower wire. Thus the top can be of less width than the bottom, which saves weight and makes the rod much easier to hold in the wind.

We find that it is safer for the instrument man to do all the reading, as we have to pick up rod-men where we can. This prohibits the use of a lower target. The method is also quicker.

Red is not plainly distinguishable from black at long distances.

Owing to the length of spring-wagon boxes, a rod when folded should not be over 7 ft. long. Also it is better to read the full width of the two wires, as the half widths give a check. This should always be done when possible, and this method requires a long rod. All rods should have a case, and this case should fit loosely. If made tight it soon wears out. We generally make a long narrow bag out of canvas, long enough to fold back over the end of the rod so that it can be tied with a string.

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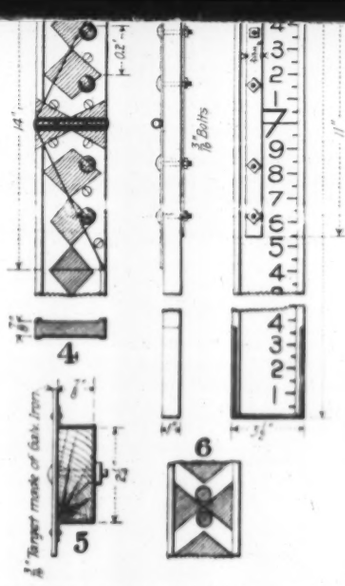

Folding Stadia and General Survey Rod.

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co-ordinate and azimuth marks for their locality, and heavy penalties are provided against their disturbance. Azimuth over these marks is obtained by solar observations. Latitude and longitude are calculated approximately from the location monuments at which the traverse started. A prismatic eye-piece is used and the image of the sun brought to tangency with the sides of the quadrants made by the intersection of the cross-wires. Stellar observations are also very valuable, especially for a check against solar observations, the star observed being identified by a star-chart. In each observation eight sets are taken, four with telescope direct and four reversed, thus eliminating instrumental errors, and the mean taken as the azimuth. The mean of this observation and another taken on a different half-day gives a final azimuth that is correct to within 15" ordinarily. On intermediate triangulation work azimuth is obtained more precisely.

The surveys for the different classes of land, as distinguished by the Land Act, differ very little. All lots are marked by two concrete corner monuments about 8 ins. square by 24 ins. long, marked P L S/B L (Public Land Survey-Bureau of Lands), which are tied by traverse to the nearest location monuments. A closed traverse is made around the parcel, the corners being taken as side-shots wherever rough or wooded land is encountered. An error of 1 in 1,500 is allowable on agricultural lands of the poorer class, while not more than 1 in 5,000 is allowed on valuable town property. Adjacent owners are notified to be present during the survey of the lot, and notes are taken on points affecting the validity of title.

All fieldwork is computed in duplicate in the field, and checked in the central office, a pencil sketch accompanying the field returns. Traverse is computed on a form, scheduled for the logarithmic multiplication of sines and cosines of the deduced bearings by the distances, these giving latitudes and departures which algebraically give Northings and Eastings, from the addition of which the co-ordinates are obtained. The error of closure is distributed among the latitudes and departures, each being corrected a part of the error in the proportion that it bears to the total latitudes or departures. The error in azimuth (1' to 2' allowable, according to the length of the traverse) is distributed in the field. The computation of the bearings, distances, and area of the lot is made upon an area sheet, logs being used always. The Northings and Eastings of the line from traverse station to corner gives the co-ordinates of each corner; subtracting the co-ordinates of each corner from those of the preceding one gives the latitudes and departures of the lot lines and from these are taken bearings and lengths of the respective sides. The products of the D. M. D.'s by the latitudes give the partial areas, which summed algebraically give twice the final area. This computation is made in the central office and the final plat made which with the data affecting title, the field notes, and the computations, is filed in an envelope, duplicates having been made for the Court of Land Registration which issues title.

The Cadastral Survey is the best development of survey practice in the Islands. A cadastral survey is made of a valuable section of land, such as one for which irrigation is projected. Since an area of 6,000 hectares may contain as many lots of every possible shape, two corners of each requiring two concrete monuments, such a survey calls for a special mode of procedure. The plane co-ordinates of a few points are obtained by triangulation, if no Coast and Geodetic station is immediate; from these the area is brought under control by a closed primary traverse, well encompassing the area, each station being a cross on a bolt set in concrete filled into several joints of bamboo, the top being flush with the surface of the ground. No course is less in length than 200 m., nor more than 2,000 m. The deflection angles are measured with a transit reading to 30" or preferably to 10", an error of closure less than 10" being desired. Azimuth is then calculated, allowing for the convergence of meridians, and checked against a series of solar or stellar observations, taken over about one-fourth of the courses. Chaining is with a standard 100-m. tape, supported, temperature and pull corrections being made. The mean of two such chainings is taken; the allowable error of closure is 1 in 50,000 for the mean of two chainings. Curvature corrections are made and co-ordinates calculated.

The area is then covered by a net of secondary traverses in which an error of 1 in 5,000 is allowed. The stations of this traverse are like those of the primary traverse. All primary and secondary traverses are platted upon sheets to a scale of 1 to 2,000; upon these sheets mounted on small plane-tables the lot lines are sketched by native parties with alidade, scale, and chain, orientation being made over the traverse courses and checked by a magnetic needle mounted on one edge of the board. All data bearing upon the individual's claim to title is recorded, the number of the record being written with the claimant's name upon the sketch sheet within the lot. The corners are well marked on the ground by stout stakes. On a large area a number of such parties are put and the sketching proceeds very rapidly. As each sheet is finished a monument setting party takes the sheet and sets the monuments as required. The sketch sheet is later used as a guide in the final lot survey, which is made from tertiary traverses, the corners being taken as side shots. To insure final agreement as to boundaries, or record conflicts, the claimants are notified ahead by cards delivered them by messenger that their presence is required during the survey, and the information pertaining to the same is filed upon duplicates of the notification cards. Every item of information relating to the individual lots is recorded upon cards which are filed under the number of the sheet upon which they have been sketched.

A progress map kept up to date with the work gives the key to the successful distribution of the work which at all times is in all stages of completion. The part of this work that merits the attention of the reader is the use of the card indexing system, which takes care of all the otherwise tedious and hard-to-handle information.

This cadastral system method might be applied to great advantage by engineers generally in the development of land units of considerable size, in the survey of which old-time methods are still in common use. It is probably no over-statement to say that, not counting the surveys of some city districts, there is no section of the United States having the same area that has such provision for surveys of its lands as have the Philippine Islands.

A Filing and Indexing System for a Small Office.*

By J. W. SEAVER, JR.†

For the past few years the writer has used in his office, with great success, the system herein described, with a force consisting of one draftsman (permanently employed) and a clerk (stenographer). The time actually needed to keep the system up to date has never exceeded 15 mins. a day, and in case of press of business the work can go over for a week without appreciable harm. It seldom happens, however, that a few minutes in each day cannot be found for this work.

On its arrival in the office each book, pamphlet, periodical, or printed report other than trade catalogue is given a serial number; this is shown by a small label pasted on the cover or (preferably) on the back, together with a letter, if belonging to any especial class. Periodicals regularly received, like Engineering News and the proceedings of societies to which I belong, are kept in temporary binders and are numbered only by volumes. Books on special subjects, or text-books (Trautwine, Searles, Johnson, etc.) are simply numbered in order to keep a record of the library; and when removed from the office, are charged to the person taking them out. This little precaution has saved many a dollar; persons are so prone to forget about a borrowed book.

As soon as labeled the periodicals are placed in a box marked "Read," and [illegible] under my personal inspection, as I try to [illegible] least skim through them all. Often they are taken home for a thorough reading at night, or by using spare moments in the office for [illegible] purpose it is generally possible to mark every article of importance. After leaving my hands they go to a box marked "File," from which the clerk indexes them at his leisure. This is done on a common 3 × 5-in. card, such as is ordinarily used in card indexes. In the upper left-hand corner is placed the general subject heading, which, for example, we will say is "Dams." On the line below is placed the title of the article or a synopsis of it, followed by the number of the periodical and page, thus:

> DAMS.
>
> Stresses in Masonry Dams.
>
> 117 24

This card is then placed in a drawer and behind the proper guide card, which, in this case, would probably be marked "Dams," and the article can be found at any time by looking in book (or pamphlet) No. 117, on page 24. The guide cards, which I use in preference to an alphabetical arrangement, could be labeled to suit the personal taste of the user. Some of those in use in this office are as follows: Dams; Hydraulic Data; Retaining Walls; Waterproofing; Sewage Disposal; Drainage; Tar and Oil for Roads; Piers and Abutments; Track Work; Highway Bridges; Electric Transmission; Piling for Foundation; Concrete Tests; Timber Preservation; Water Purification; Sidewalks, Curbs, and Gutters; City Pavements; Bridges (general); Arches; Street Railways; Canals; Borings and Test Pits; Cements; Flood Prevention; Reservoirs; Roads Macadam; Culverts; Trestles; Tunneling; Sewers (general). This will be governed largely by the kind of business one is engaged in. The greater the subdivision, the less difficulty in finding the exact article desired and less necessity for any cross-referencing.

After the card is placed in the drawer, the periodical is put in the bookcase, and, for further convenience, the shelves are divided into six sections: (A) all journals, proceedings, transactions, or reports of the various technical societies; (B) all matter relating to forestry, timber supply, consumption and tests, wood preservation, and conservation; (C) mineralogy, geology, soils; (D) water supply, irrigation, drainage, water power, and hydraulic data; (E) roads, road materials, road making; (F) miscellaneous topics and periodicals occasionally received, but not regularly subscribed for. The designating letter is usually placed on the label to assist in finding the book with a minimum of trouble. An asterisk (*) denotes that the article is in unbound form, which also simplifies the search.

Trade catalogs occasionally contain data of considerable value to the designing engineer, and, when found to do so, are also indexed in the general index under appropriate heading. All catalogs and current price lists are filed in pasteboard boxes (transfer cases), numbered on the back, and a catalog index is kept separate from the general index. This is also on the regulation 3 × 5-in. card, and has a drawer devoted to its exclusive use. The cards are in the form below:

> Name of Firm **Chicago Steel Tape Co.**
> Address **6229 Cottage Grove Ave., Chicago**
> Commodity **Engineers' Field Equipment**
> **Tapes, Rods, Sight Poles,** Etc.
> Date **4-13-09** **File Catalog 7**

Generally two cards are used—one filed alphabetically under the firm name, the other (duplicate) under the name of the principal commodity offered. There may be times when more than one card will be necessary, but not often.

Specifications are kept in document file boxes of cardboard and indexed in the general index under their appropriate headings. This method of indexing also applies to those particular clauses in specifications which are so often discussed in the engineering periodicals.

Hence it will be seen that there are but two indexes kept in the office—the general and the

*From the "Transactions" of the Engineering Association of the South, 1910 (Vol. XXI); Nashville, Tenn.

†Waynesville, N. C.

catalogue. The former now contains 2,200 cards under about 350 headings; the latter, nearly 1,800 cards, representing some 500 catalogues.

In the drafting room it is required that all drawings conform as nearly as possible to a standard size: 12 × 18, 18 × 24, 24 × 30, 30 × 36, 36 × 42 ins. All drawings up to the last size are filed in drawers, after being first placed in cardboard portfolios. For convenience, not more than 25 drawings should be put in each folio, which is numbered, as this reduces the task of finding a particular drawing to a practical minimum. For larger drawings and profiles pasteboard tubes are used. These tubes are inexpensive, and, by pasting detail paper over the ends, can be made absolutely dustproof; they are numbered on the label and kept on a rack made by driving 80d nails into a couple of 2 × 3-in. studs. In this way they use but little space in the drafting room, and yet are easy of access.

The following method is used in indexing all drawings, whether they originate in this office or come from outside sources. When a drawing is commenced, it is given the next unused serial number, and a card is made out thus:

Drawing Number **2891**		File in **P. 12**
Description **Standard frame bent trestle**		
.....		
For **X. Y. Z. Railroad Co.**		
Field.....	Draw. **Jones**	Date **3-24-09**
Book.....	Page.....	Comp. **Brown**
Sketch	Draw.	√ Trac. Blue

This card is then placed in the back part of the numerical index drawer, and the standard imprint used in this office is placed in the lower right-hand corner of the drawing. This contains all the information on the first four lines of the card, and is necessary in order to replace the drawing in its proper file after use. The letter "P" or "T" shows at a glance whether the required drawing must be looked for in a portfolio or tube, and the number following indicates which particular one to look into. At least once a week the recent additions in the numerical index are cross-indexed in the alphabetical drawing index. This is the most comprehensive and complicated index in the office, as it is well to cross-index each drawing thoroughly, and it often requires five or more cards for each drawing to do this properly. Nothing is more embarrassing than to have a client call for a drawing and not be able to produce it with promptness, so a little extra work in cross-referencing is time well spent.

These alphabetical cards should refer only to the numbered cards in the numerical index, and not to the files direct. Then if a drawing is removed from the office, or (its usefulness having ceased) is destroyed, such fact can be noted on the numerical card or corresponding number easily, while a search through the entire alphabetical file would be necessary in order to remove all the cross-referenced cards relating to that one drawing. For this index cards may be used as shown below:

Title **Frame bent trestle (Standard)**		
.....		
For **X. Y. Z. Railroad Co.**		
Date **3-24-09**	Drawing Number **2891**	
Sketch	Draw.	√ Trac. Blue

Computations made in connection with all drawings are kept in manila envelopes bearing the same number as the drawing, and are filed in pasteboard document files. In this way they require no additional indexing. There may be some question as to the advisability of filing blue prints and drawings together, but so far it has worked satisfactorily and greatly simplifies matters by reducing the necessary indexes. It cost less than $50 to install the entire system, and we feel that it has more than paid for itself. The fact that my engineering friends consult my general index on special articles from time to time seems to prove its worth to others as well as to myself.

NOTES.

Capacity of Tanks.—A satisfactory reply to Wm. Brown's query (in our issue of Sept. 21) concerning formulas for capactiy of horizontal tanks is given by Mr. Edward Godfrey, Monongahela Bank Bldg., Pittsburgh, Pa.

A table of areas of circular segments is given in Godfrey's "Tables," from which is read a coefficient, the ratio of the area of the segment to the area of the circumscribed rectangle. To use this table, multiply the chord of the segment by its middle ordinate or versed sine, and multiply by the coefficient from the table. The table gives the coefficient for every degree of half-angle of the segment, but as the ratio of rise to chord is also given either the angle or the rise ratio may be used to enter the table.

Mr. Godfrey calls attention to the fact that a very flat circular segment (i. e., one having small central angle) approximates a parabolic segment, and has same area-coefficient (2/3). At the other extreme, a full semicircle has the coefficient 0.7854. All intermediate segments will have coefficients between 0.6667 and 0.7854. The table shows that the parabolic coefficient is sufficiently accurate over quite a range; the coefficient rises to 0.6677 for 10° half-angle, or 20° central angle, so that by using the parabolic rule for all segments up to 20° central angle or 0.0437 ratio of rise to chord the error remains below 0.1%.

Mr. Godfrey's letter says that this table once meant the difference between success and failure in finishing on time a piece of work where the contents of a cylindrical tank had to be calculated for different depths of liquid. He remarks:

> The application to a tank may be as follows: Divide the vertical radius from the center down into even inches (or other unit), and by right triangles find the horizontal chords through these points of division. From the ratios between these chords and the versed sines (depths of liquid) find the area coefficients in the table. The areas multiplied by length of tank will give the volumes for all depths up to the center. For greater depths, the differences between the successive volumes may be added.

To get the volumes of the spherical segments in case of dished heads, Mr. Godfrey recommends dividing the vertical radius into equal parts as before, scaling or calculating the middle ordinate of each section, and getting the horizontal areas of the dished part by using the table above mentioned. The areas of the horizontal mid-section of each part being thus found, multiplying by the height of the part gives the volume. In the case of a tank 100 ins. in diameter, with ends dished 10 ins., the radius was divided into 10-in. sections, and the volumes of the dished end found by the method described were 2% too great. In view of the small proportion of the tank volume contained in the dished portion, this error is usually negligible, being probably less than the divergence produced by irregularities of workmanship.

The sum of the volumes of parts of the segment should be checked against the volume of the whole segment, which is, very approximately, $V = 2/3\ \pi\ R^2 b - 1/3\ \pi\ a^2\ (R - b)$, in which R is the radius of the sphere, a is the radius of the tank, and b is the ordinate of the dish at the middle. Or, as a rough check, the volume of a flat circular segment is nearly equal to the area of the base times one-half the altitude, of $V = 1/2\ \pi\ a^2 b$.

A Rule for Computing the Areas of Circular segments is given by Mr. G. A. L'hommedé, of the City Engineer's Office, Los Angeles, Cal., which is of direct application to the tank problem, but also has wider application. It does not require a special table, but it is accurate only for segments whose central angle does not exceed a moderate amount. The rule is:

To three times the logarithm of the number of minutes in the central angle, add twice the logarithm of the radius, and add the constant logarithm 8.3105—20; the result is the logarithm of the area.

Example: Find the area of a segment of a circle of 800 ft. radius and 7° 32′ central angle.

3 log 452	=	7.9653
2 log 800	=	5.8062
constant log	=	8.3105
log area		2.0820
Area	=	121 sq. ft.

The author of the rule states that when the radius does not exceed 1,000 ft. and the central angles does not exceed 15°, the area of the segment as found by the rule is less than 1 sq. ft. in error.

The rule is derived by expanding the formula for the area (difference between sector and triangle) in a series, and neglecting all terms after the first two. The constant is then decreased in the ratio 0.9965 to extend the range of application of the rule without exceeding the maximum error of $0.000001\ r^2$. Without the modification of the constant, this error is reached at 10° 49′ central angle, while the modification makes the rule applicable to 15° 9′ central angle within the same limit of error.

Mr. L'hommedé remarks that nine-tenths of all the segment areas which have to be calculated in surveying work fall in the range over which this rule can be used.

Drafting Ink in the Cold Tent.—On the question whether liquid drawing-ink is spoiled by freezing we have several letters:

Sir: Regarding frozen ink in the office tent: The writer put in a winter in North Dakota several years ago with a locating party. The temperature sunk to —46° and averaged —40° for ten days, after which it became warm again, the thermometer rising to about 16 below zero. The tent was feebly heated by a Sibley stove, whose only feature is portability. In the evening, by dint of careful watching and the insertion of a chunk of lignite on an average of once in ten minutes, a temperature several degrees higher than the outside was induced. The men in the office tent would crawl into their tarps, lace up, and sleep comfortably until morning. Reveille would find them shiveringly getting into their clothes, while other members would be breaking 3 inches of ice in the water pails for the daily ablutions. During the day the camp draftsman, drafting pen in one hand and coal shovel in the other, managed to keep up with the progress of the field party, which was using snowshoes and skis on the high spots of the topography.

Each man in the office used to wrap up a couple of bottles of drafting ink in a sock or towel, and put it into his bed roll, where the heat of the body would keep it above the freezing point, and on moving day the ink was carried next to the body in an inside pocket or under the shirt. Thawing out the ink seems to free the ammonia and causes the ink to flake and cake up. Perhaps a few drops of ammonia would help some, but it is more advisable to throw it away if it is possible to get a new supply. At all events, a stick of the old style India ink should be kept in the camp chest for just such emergencies, as long as locating parties are kept in the field with such facilities as are afforded by the purchasing agent who sends out supplies instead of allowing the engineer to pick out what is needed in the light of his experience.

Locater.

Chicago, Ill., Sept. 23, 1911.

Sir: A few years ago I had my office for a year in a tar-paper board shack in eastern Nevada. For at least three months in the year the temperature each night fell well below freezing, while a wood-stove was able to afford sufficient heat for comfort during the day time except in extreme cold spells. The drawing inks were thus subjected to a severe test of freezing and thawing. I used the ordinary ¾-oz. bottles of Higgins' black waterproof and several colored inks. Some of the bottles of colored inks lasted during my year's stay in the district and I noted no deterioration from freezing and thawing. The black waterproof, being used up more quickly, was not tested so severely, but some bottles must have gone through at least a month of daily freezing and thawing, with no noticeable effect on the properties of the ink. The inks would not work well if it were attempted to use them before the entire contents of the bottle was thawed, but there seemed to be no ill effects from hastening the process by putting the bottles in warm water.

As all supplies had to be ordered from San Francisco and the date of delivery was very uncertain, I ordered an 8-oz. bottle of black waterproof so as to be in no danger of a shortage. The first night after its arrival the freezing ink burst the bottle, and as this was not noticed until well into the next day when thawing had been completed practically all was lost. None of the ¾-oz. bottles broke from freezing. Freezing did injure some of the ordinary writing fluids very noticeably.

Gragg Richards.

119 W. 82d St., New York City, Sept. 25, 1911.

Sir: In a location camp in the winter of 1898, when the mercury sometimes registered 20° below zero, it was our custom to bury the ink each evening, near the Sibley stove, in the earth which formed the tent floor.

On one occasion, having worked on a tracing far into the night, we quit, thinking more of bed than of the ink, and left it on the table. The next morning, on entering the then warm

office tent, we saw a broad black river flowing majestically across our tracing. The ink did not appear to be in the least injured. It dried opaque, and glossy, and was as difficult to remove as though it had been fresh from the store; but the bottle—well, the freezing certainly had rendered it useless.

A stick of good India ink in the draftsman's kit insures a drawing, even though the liquid ink-bottle be broken by freezing or other accidents.

Orrin E. Stanley.

Portland, Ore., Sept. 25, 1911.

Sir: To find if freezing spoiled drawing ink, as stated in a book on Engineering Drawing and mentioned in Engineering News of Sept. 21, 1911, I froze some black drawing ink (Higgins). I can detect no difference between this ink, when thawed, and some which was not frozen. This letter is written with drawing ink which has been frozen. [It looks like any other writing with drawing-ink.—Ed.]

With a little ice and salt any one can find whether a given ink will stand freezing.

John H. Opp,
Junior Engr., Mississippi River Commission.

Memphis, Tenn., Sept. 27, 1911.

Standard Timber Bulkheads of the City of Seattle, Wash.

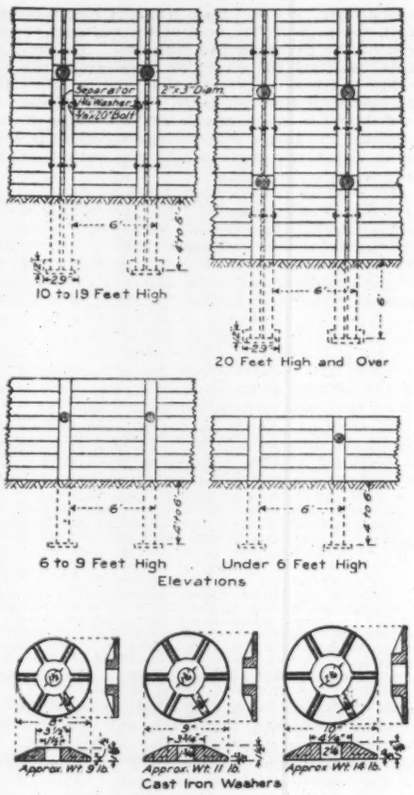
The accompanying illustrations and data are taken from the "Standard Plans and Specifications of the City of Seattle," recently issued by the City Engineer, Mr. R. H. Thomson, M. Am. Soc. C. E. They give in detail the standard practice of that city for the construction of plank bulkheads for a variety of purposes.

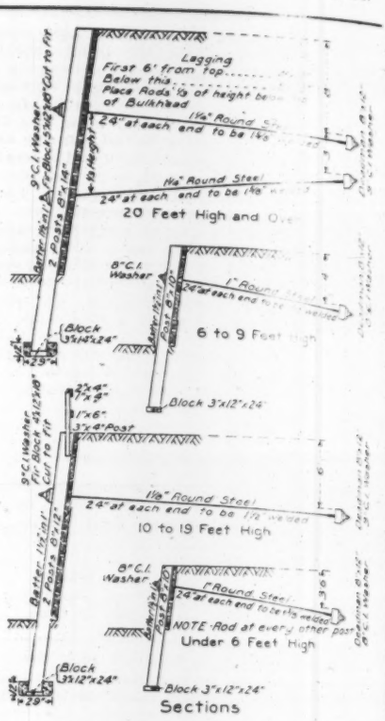
All posts are set on 3 × 12 × 24-in. blocks laid in holes excavated to a depth sufficient for a good foundation. When necessary a footing of concrete is added under and around the posts and blocks. The posts are set on batter of 1½ ins. in 1 ft. In refilling the holes the earth should be thoroughly tamped. The location of the anchor rods and the anchors or deadmen are shown on the plans for each height of bulkhead. The rods vary in length from 15 ft. for a 4-ft. wall to 37.5 ft. for a 25-ft. wall.

All lumber not exposed, except ends of timber (unless otherwise specified) is given two coats of hot coal tar or some other preparation approved by the City Engineer. The lagging is secured to the posts with 8-in. wire nails for 4-in. lagging, and 9-in. wire nails for 5-in. lagging. Each plank in the lagging is secured to each post by two nails.

The rods used are of round steel and vary from 1-in. in diameter for 4-ft. bulkheads to 1⅝-in. diameter for bulkheads higher than 20 ft. All rods have welded ends 2 ft. long ⅜-in. larger in diameter than the rod itself, and threaded for a distance of 8 ins. The post ends of the rods are capped with standard nuts, special cast-iron washers, shown on the plans in detail, and wood blocks cut to fit the batter of the posts. The other ends of the rods pass through an 8 × 12-in. timber deadman and are capped with washers and nuts as at the posts. All rods and other iron are painted with some preservative paint satisfactory to the engineer.

The sizes of posts and lagging for each bulkhead and the spacing of posts are shown on the plans. The unit weights of the ironwork and the bills of material per unit length of wall are given in Tables I. and II.





STANDARD TIMBER BULKHEADS; CITY OF SEATTLE, WASH.

TABLE I.—WEIGHTS OF IRON FOR TIMBER BULKHEADS.

Material.	Size, ins.	Weight, lbs. per ft.	Lbs. each.
Rods	1	2.67	....
Rods	1⅛	3.38	....
Rods	1¼	4.17	....
Rods	1⅜	5.05	....
Rods	1½	6.01	....
Rods	1⅝	7.05	....
Separators	2 × 30	....	37
Bolts	⅝ × 20	....	2.0
Nuts	1⅜	....	2.5
Nuts	1½	....	3.2
Nuts	1⅝	....	4.0
C.-I. washer	8	....	9.0
C.-I. washer	9	....	11.0
C.-I. washer	10	....	14.0
W.-I. washer	1¾	....	0.1

TABLE II.—MATERIAL REQUIRED FOR TIMBER BULKHEADS.

Height of bulkhead.	Timber, ft. B.M. per ft. length.	Iron, lbs. per ft. length.	Length of rods.
4	33.9	6.0	15
5	40.1	6.0	15
6	46.3	12.0	15
7	52.4	12.0	15
8	58.6	12.0	15
9	64.7	12.0	15
10	96.4	18.0	15
11	104.1	18.8	16.5
12	111.8	19.7	18
13	119.4	20.5	19.5
14	127.1	21.4	21
15	134.8	22.2	22.5
16	142.4	23.0	24
17	150.1	23.9	25.5
18	157.8	24.8	27
19	165.4	25.6	28.5
20	193.6	58.7	30
21	201.7	60.8	31.5
22	209.8	62.9	33
23	217.9	65.0	34.5
24	226.0	67.0	36
25	234.1	69.0	37.5

A Table of Decimal Equivalents.

A rather novel and convenient arrangement distinguishes the following table of decimals equivalents of parts of inches and feet. It was made up by C. P. Wiweke, of the Barge Canal office at Albany, N. Y.

The scheme of the table will be apparent from the headings to the table.

DECIMAL EQUIVALENTS.

Ft. = In.	= In.	= Ft.	Ft. = In.	= In.	= Ft.	Ft. = In.	= In.	= Ft.	Ft. = In.	= In.	= Ft.	Ft. = In.	= In.	= Ft.
	1/16	.005208		11/64	2 1/16	.171875		4 1/16	.338541		6 1/16	.505208		8 1/16	.671875	27/32	10 13/16	.843750
	1/8	.010416			2 1/8	.177083	11/32	4 1/8	.343750		6 1/8	.510416		8 1/8	.677083		10 7/8	.848958
1/64	3/16	.015625			2 3/16	.182291		4 3/16	.348958	33/64	6 3/16	.515625		8 3/16	.682291		10 15/16	.854166
	1/4	.020833	3/16		2 1/4	.187500		4 1/4	.354166		6 1/4	.520833	13/16	8 1/4	.687500		11	.859375
	5/16	.026041			2 5/16	.192708	23/64	4 5/16	.359375		6 5/16	.526041		8 5/16	.692708	55/64	11 1/16	.864583
1/32	3/8	.031250			2 3/8	.197916		4 3/8	.364583	17/32	6 3/8	.531250		8 3/8	.697916		11 1/8	.869791
	7/16	.036458	13/64		2 7/16	.203125		4 7/16	.369791		6 7/16	.536458	49/64	8 7/16	.703125		11 3/16	.875000
	1/2	.041666			2 1/2	.208333	3/8	4 1/2	.375000		6 1/2	.541666		8 1/2	.708333	7/8	11 1/4	.880208
3/64	9/16	.046875			2 9/16	.213541		4 9/16	.380208	35/64	6 9/16	.546875		8 9/16	.713641		11 5/16	.885416
	5/8	.052083	7/32		2 5/8	.218750		4 5/8	.385416		6 5/8	.552083	25/32	8 5/8	.718750		11 3/8	.890625
	11/16	.057291			2 11/16	.223958	25/64	4 11/16	.390625		6 11/16	.557291		8 11/16	.723958	57/64	11 7/16	.895833
1/16	3/4	.062500			2 3/4	.229166		4 3/4	.395833	9/16	6 3/4	.562500		8 3/4	.729166		11 1/2	.901041
	13/16	.067708	15/64		2 13/16	.234375		4 13/16	.401041		6 13/16	.567708	47/64	8 13/16	.734375		11 9/16	.906250
	7/8	.072916			2 7/8	.239583	13/32	4 7/8	.406250		6 7/8	.572916		8 7/8	.739583	29/32	11 5/8	.911458
5/64	15/16	.078125			2 15/16	.244791		4 15/16	.411458	37/64	6 15/16	.578125		8 15/16	.744791		11 11/16	.916666
	1	.083333	1/4		3	.250000		5	.416666		7	.583333	3/4	9	.750000		11 3/4	.921875
	1 1/16	.088541			3 1/16	.255208	27/64	5 1/16	.421875	19/32	7 1/16	.588541		9 1/16	.755208	59/64	11 13/16	.927083
3/32	1 1/8	.093750			3 1/8	.260416		5 1/8	.427083		7 1/8	.593750		9 1/8	.760416		11 7/8	.932291
	1 3/16	.098958	17/64		3 3/16	.265625		5 3/16	.432291		7 3/16	.598958	59/64	9 3/16	.765625		11 15/16	.937500
	1 1/4	.104166			3 1/4	.270833	7/16	5 1/4	.437500		7 1/4	.604166		9 1/4	.770833	15/16	11 15/16	.942708
1/64	1 5/16	.109375			3 5/16	.276041		5 5/16	.442708	39/64	7 5/16	.609375		9 5/16	.776041		11 31/32	.947916
	1 3/8	.114583	9/32		3 3/8	.281250		5 3/8	.447916		7 3/8	.614583	25/32	9 3/8	.781250		11 63/64	.953125
	1 7/16	.119791			3 7/16	.286458	29/64	5 7/16	.453125		7 7/16	.619791		9 7/16	.786458	61/64	11 63/64	.958333
1/8	1 1/2	.125000			3 1/2	.291666		5 1/2	.458333	5/8	7 1/2	.625000		9 1/2	.791666		11 63/64	.963541
	1 9/16	.130208	19/64		3 9/16	.296875		5 9/16	.463541		7 9/16	.630208	51/64	9 9/16	.796875		11 63/64	.968750
	1 5/8	.135416			3 5/8	.302083	15/32	5 5/8	.468750		7 5/8	.635416		9 5/8	.802083	41/32	11 63/64	.973958
9/64	1 11/16	.140625			3 11/16	.307291		5 11/16	.473958	41/64	7 11/16	.640625		9 11/16	.807297		11 63/64	.979166
	1 3/4	.145833	5/16		3 3/4	.312500		5 3/4	.479166		7 3/4	.645833	13/16	9 3/4	.812500	63/64	11 63/64	.984375
	1 13/16	.151041			3 13/16	.317708	31/64	5 13/16	.484375		7 13/16	.651041		9 13/16	.817708		11 63/64	.989583
5/32	1 7/8	.156250			3 7/8	.322916		5 7/8	.489583	21/32	7 7/8	.656250		9 7/8	.8229[illegible]		11 63/64	.994791
	1 15/16	.161458	21/64		3 15/16	.328125		5 15/16	.494791		7 15/16	.661458	53/64	9 15/16	.828125	1	11 63/64	1.000000
	2	.166666			4	.333333	½	6	.500000		8	.666666		10	.833333			

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Unloading Ship's Cargo by Machinery.

The increasing demand and necessity for the rapid unloading of ship's cargo is one of the many phases of the problem of mechanical handling of freight, and probably the greatest development in this particular direction has been on the Great Lakes in connection with the large modern steamers carrying coal and ore. A spur to the introduction of time-reducing machinery in this case is that traffic is largely tied up (and in the case of ore entirely stopped) during the winter season. Consequently, it is of the utmost importance for the steamers to make as many trips as possible during the season of navigation, and this means that steps must be taken for rapid loading and unloading. As these ore vessels run regularly to certain points on the lower lakes, the practice has been to establish unloading machinery on the docks or piers at these ports and to provide an ample number of hatchway openings in the deck of the ship so as to facilitate the handling of the unloader buckets.

Undoubtedly this is the most economical method where large quantities are handled continually, as at these ore ports. There are cases, however, where the quantity is not such as to warrant so large an investment in machinery, or where the ship may deliver its cargo at various ports at different times. In these cases, however, rapid unloading is still of great importance, so that the steamer may be kept idle for as short a time as possible. This condition has been met, both in this country and abroad, by equipping bulk-cargo steamers with their own unloading plant. Such plant is in general of two classes: (1) an equipment of numerous derrick masts, booms and hoists or winches for handling the cargo in buckets; and (2) an equipment of conveying machinery. Instance of both these classes have been described in our columns, and elsewhere in this issue we describe some interesting installations of the second class. In Europe, there has been a greater tendency to the use of the first system of unloading, and in a number of ships the masts have been replaced by rows of derrick posts along opposite sides of the deck. Steamers of this sort were described in our issue of April 4, 1907. One of these was an ore steamer with engines placed at the extreme stern (as in our lake steamers) and with a hold capacity of 11,000 tons of ore. This had seven pairs of derrick posts or side masts, with 24 booms, and could discharge its entire cargo in 27 to 34 hours, or say 360 tons per hour. Of course this does not equal the speed attained by elaborate unloader machinery erected on the dock, but it is very much higher than that which is possible by ordinary methods, and (as explained above) there are commercial conditions which may render it desirable for the ship to carry its own unloader plant. A somewhat similar arrangement, but with a row of towers carrying the booms, has been introduced on some of the new colliers for the U. S. Navy.

For package freight or general cargo, the conditions are different. The packages must be handled with some degree of care, and they require to be loaded into the sling or crate for hoisting. At European ports various types of cranes and conveyor cranes are used, while in this country reliance is placed almost entirely upon the ship's winches and cargo booms, with hand trucks on the piers. In a few cases portable conveyors are used to carry the packages between the ship and the dock, thus reducing the amount of trucking. A recent design of such a conveyor system has such flexibility that it can be run horizontally or at any angle. In this way packages in the hold may be placed on a steep section of the conveyor, raised to the level of the deck, carried across the deck to the side of the ship and then carried down onto the pier or into a railway car. In the same way packages on the wharf may be picked up by the conveyor and carried into the hold, where they are received by the men engaged in storing the cargo. The unloading of ore at lake ports has been carried to a high degree of speed and economy, and some of the other methods noted above are indications, it seems to us, of coming improvements in the same direction for the handling of the general cargo of freight steamers.

Testing Masonry Dam Foundations with Compressed Air.

In view of the interest excited in the subject of dam foundations by the failure of the dam at Austin, Pa., it may be of interest to call especial attention to the method used for testing the foundations in building the great dam across the Mississippi River at Keokuk, Iowa. As set forth in the description of this work in our issue of Sept. 28, holes are drilled in the foundation rock along the axis of the dam at intervals of 36 ft. These holes are put down to a depth of 36 ft., and after drilling they are connected to a compressed-air main and subjected to an air pressure four times as great as the hydrostatic pressure at the bottom of the hole if filled with water. In this way, the tightness of the rock and the presence of any seams or fissures therein are determined.

More Slide Sensations from Gatun.

A new crop of scare headlines in the newspapers concerning the Gatun Dam at Panama has appeared since the dam failures in Pennsylvania and Wisconsin. The press correspondents well understand the psychologic moment at which to market a story. In this case, however, the scare was all in the headline and not in the story, the latter consisting merely in a quotation from the "Canal Record" of Oct. 5 which reported a so-called slide in the earth filling back of the walls of the lower lock at Gatun.

The rock on which this lock is founded is overlaid by 30 to 50 ft. of soft and slippery earth, which slid into the lock pit a number of times while excavation was in progress and considerably delayed the concreting of the foundation. When the lower part of the lock wall was finally in place, this soft earth flowed in and filled the space behind the wall to some depth. A rock fill was made on top of this and tracks were laid on it for the traveling cableways which handle the concrete. Since this was done the rock-fill has settled at some points and risen at others as a result of the soft slippery material underneath the rock fill.

It is almost needless to say to our readers that the occurrence has no significance as regards the stability of either the locks themselves or the Gatun Dam; but it is a good enough foundation on which to build sensational stories to excite public alarm.

The Jersey City Water-Supply Purchase and the Attempted Water Monopoly.

Another chapter in the attempt to monopolize the water-supply of northeastern New Jersey was closed early in the present month (Oct., 1911), when Jersey City paid the Jersey City Water Supply Co. nearly seven million dollars for the Boonton dam and reservoir, on the Rockaway River, the steel conduit from the reservoir to Jersey City, and associated water rights and right-of-way. Or perhaps we should say that this incident was a sequel to the attempted monopoly just mentioned.

We reviewed at some length the main portion of this attempt at a water monopoly so long ago as our issue of April 25, 1895. At that time the original scheme to supply New York and Brooklyn with water from the upper Passaic River had been practically abandoned (although fitfully revived afterwards); a contract to build works for Newark had been made, which contract bound Newark not to sell surplus water to other communities; contracts with these outlawed or outcontracted municipalities and with still other cities, had been closed; and every effort was being made by the water monopolists to capture the Jersey City prize. The latter proved to be no easy task. It was not until the eighth solicitation of bids, beginning in 1892, that Jersey City awarded a contract, or one that held. With the award then made to Patrick H. Flynn and subsequently assigned to the Jersey City Water Supply Co. it appeared to some that the water monopolists had been beaten at one of their main points. But with its real and apparent control of water rights, and with the strength of its financial relations, the water monopolists finally "won out," and really dominated the execution of the Jersey City Water Supply Co. contract.

To make their position apparently impregnable the water monopolists next came down the Passaic River and established pumping and purification works at the lowest point from which, pollution considered, it was feasible to take a supply. From this point Paterson, Passaic, Montclair and various other communities have been supplied with filtered water for some years past.

Recently two clouds have appeared on the water monopoly horizon, one of which may be said to have broken into damaging storm, while the other is still threatening. We refer to litigation against the monopoly claims to the water of the Passaic, which has been decided adversely to the monopoly, though with ultimate results not yet fully determined; and to the creation and perpetuation of a State Water Supply Commission.

We say "and perpetuation" because a State Water Board was created thirty years or so ago, and outlined a state water-supply plan for northeastern New Jersey which would put an early quietus on the water monopoly, and was slowly but firmly smothered by the withholding of appropriations and the failure to fill vacancies on the board.

In passing, we cannot refrain from a word of tribute to the one lone figure who, single-handed and at his own expense, conducted an unceasing but unsuccessful fight against the water monopoly—the late Lebbus B. Ward, an engineer of Jersey City. Mr. Ward was the only member of the old State Water Board whom death or change of residence had left in the State, and he kept up his fight on every possibly useful occasion until he, too, was claimed by death.

The second, or present State Water-Supply Commission, has some measure of control of all the water supplies of the State, and has authority, after being so requested, to prepare plans for joint water-supplies for two or more municipalities. It has just submitted plans and estimates for a supply from the Wanaque River for

Paterson, Montclair, East Orange, Newark, Elizabeth and lesser municipalities, designed to supplement present sources in some cases and to supplant them in others. Some of these places are now supplied by the old water monopoly.

It will be interesting, indeed, to watch the further struggle between the municipalities of northeastern New Jersey and the capitalists who for so many years were able to control the water-supply of that rapidly growing section. In the cases of Newark, Jersey City and some other municipalities, the water monopolists have been well content to sell water in bulk for the cities to distribute, or to sell the supply works on completion, as witness Newark, or soon afterwards, as in the case of Jersey City. But in these instances supplies from tributaries of the Passaic were developed in the uplands. The final struggle will be to hold the municipalities now taking water from or through the works on the lower Passaic, at Little Falls. Resort has been had to various financial and legal strategies to maintain the dominance of the water monopoly. Whether these devices will prove effective or futile depends largely upon the public spirit of the people of northeastern New Jersey, and upon whether the present State Water-Supply Commission has and uses sufficient legal authority and ability to help these communities maintain and perhaps regain their rights to the potable waters of the State of New Jersey.

How the Trusts Fail in Securing Efficiency.

Elsewhere in this issue we print a contribution worthy of the thoughtful study of every engineer who takes any interest in the current discussion concerning industrial efficiency or the other current discussion concerning the merits and demerits of the great industrial combinations which are just now under fire.

It is alleged that the harassing of these great combinations by the Sherman law and by various State legislation is working against the business interests of the country. It is declared that these great combinations are such a necessity to the conduct of business along up-to-date lines that we really cannot get along without them anyway.

The public is being assured that the benevolent gentlemen who conduct our trusts have created an enormous export trade, have reduced the costs of production and distribution, and have effected such vast benefits to the public that they ought to be coddled instead of flogged.

It is important to know the truth of the matter, and a very large number of the readers of Engineering News are in a position to know something concerning the truth of these allegations. One of these readers, whose contribution we have referred to above, tells in this issue some of the ways in which a huge combination saves at the spigot and wastes at the bunghole. What he says coincides closely with the reports that come to us from other engineers, many of them in high official positions, regarding the great difficulty of securing genuine efficiency and economy in the operation of a huge organization.

It is unquestionably true that, apart from its power over prices through the elimination of competition, the huge concern does have certain advantages or could have them if it were wisely enough managed. It could, for example, secure the highest grade of technical ability to advise concerning its operations; it could place this advice at the disposal of each of its separate plants. In the sales department, the great corporation handling business on a large scale can marshal a selling force to adequately cover a large territory, with district offices, in a manner not at all possible to a concern of moderate size. But against these and other advantages are to be set some positive disadvantages.

Reports generally indicate a lack in the great combination's managing force of the esprit de corps and "team work," which brought success to the smaller plants which were merged when the combination was formed. Almost inevitably the huge concern forfeits the personal touch between the heads and their subordinates, which is one of the most effective elements in the success of most business enterprises. To express the contrast in a single word: the head of an independent concern *leads* his organization to business success. The various heads of the "octopus" formed by the consolidation of independent concerns, seek to *drive* their subordinates along the road to efficiency. Some of the results of such driving are well set forth in the article by Mr. Vance, referred to above.

Any one who has the slightest knowledge of human nature can readily understand that efficiency in production can never be attained in any such way. The "motion-study" expert may train the unskilled worker to go through certain mechanical movements so many hours every day at a terrific rate; but when the "motion-study" expert has to deal with an employe who is working with his brains instead of his hands the "motion-study" scheme falls down.

There is a very serious aspect to this matter in connection with engineering work, and that is the deterioration in quality of product resulting from the driving method. Mr. Vance describes the results in structural engineering, but the same thing is true of mechanical engineering work. In many branches of mechanical engineering work it has been recently pointed out that America is far behind European nations and is destined to remain there until a better premium is placed on *real* engineering in this country. Mere grouping of cut-and-dried details so that they will go in place without interfering with each other is work which can be gotten out of draftsmen by the driving system; but high-class technical design, such as the leading Swiss, German and Belgium firms achieve, requires a higher grade of ability.

There are complaints that quality suffers in other respects under the driving system. The independent mill with its employes who had grown up from boyhood in the works used to have real pride in the character and quality of its product. Every man in the establishment from manager down to office boy felt that their personal reputation was at stake in maintaining the quality of the work. We fear that this important element has been largely sacrificed under the modern method of organization, where managers come and go every few months and employes are taken on and laid off with as little care and compunction as if they were so many machines or blocks of pig-iron.

There is another handicap of the trust organization which is becoming more and more manifest. The bigger the trust, the larger the amount of necessary "red tape" which must be unwound in connection with every transaction. It used to be a source of endless criticism because the "red tape" of government methods made government work so costly compared with work done by private concerns. But the "red tape" which some of our present-day trusts can boast of is quite as great as anything of which a government organization was ever guilty.

Our contributor refers to the relation of the so-called efficiency engineering to these great combinations. It is undoubtedly true that the difficult problems with which the managers of these great concerns have found themselves face to face have made necessary the employment of an outside efficiency expert. But when the efficiency expert has done his work, the combination sometimes finds itself encumbered with a lot of expensive and intricate methods, records, etc., whose final effect upon the annual yearly earnings is injurious rather than beneficial.

There are concerns of moderate size which transact a large amount of business with a very small expense for accountants and non-productive labor in general. Experience seems to show that many of these small concerns can compete with their huge rivals in both price and quality. Of course, there are many industries in which small-scale production is no longer economically possible, but this is by no means universally true. There are still broad fields where the energetic and industrious man, with moderate capital and a thorough understanding of his business, can enter the commercial world and be obliged to call no man master.

LETTERS TO THE EDITOR.

Movable Dams for Spillways in Connection With Earth Dikes.

Sir: As the question of dams is of considerable interest at present, I would like to ask a question concerning spillways for earth dams. As these dams are usually built across the narrow part of a valley an adequate spillway for flood water will frequently be so long in proportion to the dam that the economy of earth construction is doubtful if the pool level is to be kept at the elevation of the spillway in ordinary seasons.

Do you (or any of your readers) know of an earth dam with a spillway having a movable crest similar to the wicket or needle, which can be lowered in case of emergency? This would be a comparatively cheap form of construction, but I have never seen it adopted.

Very respectfully,

Paul M. LaBach.

Catlettsburg, Ky., Oct. 14, 1911.

Should the Factor of Safety of Dams be Fixed by Law?

Sir: Why not have a law to regulate the "safety factor" of dams? The safety factor could be criticized and determined without the aid of officials, through disinterested consulting engineers and required to be published.

It is common practice to use a safety factor of 2 to 3 in gravity dams, and, is it not a fact, that this ultimate strength is scarcely more than one-fifth of the lowest safety factor used in other similarly important engineering structures.

Since 10 is a common safety factor, and the lowest employed in important work, why not suggest 5 as the lowest safety factor to be used in building dams? Would not such a law avert further calamities without state supervision or other necessary regulation?

Dams would cost more but can there be any justification for a sacrifice of life?

Very truly,

Geo. E. Ladshaw.

Spartanburg, S. C., Oct. 9, 1911.

[The "Factor of Safety" is a term much misunderstood by the public and not a little misunderstood by engineers. It would seem to us extremely unwise to name in any law a required factor of safety for a dam or any other engineering structure. One reason for this is that the factor ought to be varied very widely for different structures and different parts of the same structure. Again, there are parts of a structure whose stability cannot be measured in any arithmetical way. How could any "factor of safety" be computed for the layers of stratified rock underneath the Austin Dam?—Ed.]

Should Dam Construction be Under Federal Control?

Sir: There is probably no well informed person in this country who will not agree with your argument for governmental supervision and control of dams; then why not control by the United States?

The General Government, under constitutional authority, unquestionably has control of the headwaters of navigable streams wherever interference with the flow will reduce the depth of the navigable streams themselves.

As most non-navigable streams in this country are tributaries of navigable streams, the unregulated construction and control of dams upon them will interfere with navigation; therefore, Congressional authority should be required for the construction and operation of all such dams, and should provide that they be built and operated under the supervision of the United States Engineer Department.

D. M. Andrews, M. Am. Soc. C. E.

Rome, Ga., Oct. 9, 1911.

[Our correspondent might have made his argument still stronger. Suppose a dam is to be built on the Connecticut River where it forms the boundary between Vermont and New Hampshire, or on the Delaware, where it forms the boundary between New York and Pennsylvania, or New York and New Jersey. How shall control be divided between the two states? Again a dam on the Connecticut at Bellows Falls or Brattleboro

might menace communities lower down the valley in Massachusetts and Connecticut.

On the other hand, as a matter of practical politics, there is great opposition nowadays to any extension of Federal powers over matters still under State control. True, this State sovereignty idea is causing losses amounting to tens or hundreds of millions, through the conflicting jurisdiction over interstate waters, as we pointed out a few months ago in connection with the discussion concerning the securing of water from the Ten Mile and Housatonic watersheds for emergency needs in New York City. The public, however, is ignorant of this; and conflict of authority—or no authority at all—will be the prevailing situation with respect to American rivers, we fear, for a long time to come.—Ed.]

Should an Engineer Consult a Geologist in Laying a Dam Foundation?

Sir: Notwithstanding the criticism and sermonizing over the destruction of the dam at Austin, Pa., all are wide of the real lesson of the disaster, which is the incalculable harm done to the profession by the overweening pretense of engineers who assume that it is beneath their standing to consult real sources of information.

As the Philadelphia "North American" puts it, "their wisdom in angles and pressure and resisting powers and tensile strength gave them the certain knowledge that the dam was perfectly safe."

To have consulted the county surveyor of Potter County, who knew that a mistake in judgment had been made in the selection of the site for the dam (on the axis of the Cowanesque synclinal), would have invited a puncture in the tank of vanity. To have consulted a local geologist or even the State's publications of 30 years ago on the pervious nature of the rock foundation underlying Austin, would have been a blast at ignorance.

It is true that, after the structure had partially failed, an engineer who has built dams on archaen rocks, but who was not even afforded the opportunity to visit Austin, was consulted; and a plan for reinforcing the dam with durable and massive fragments of rock which can not be procured in that region, and a cut-off extending vertically about 400 ft. through the Catskill and Chemung formations beneath the dam was recommended to the owners. Whether or not sky-hooks, the recourse of many engineers, were also suggested does not appear.

It is evident, though, that the State Water Supply Commission, which, according to p. 12 of its report, published in 1910, must have had "complete data" on this "water power system," was not consulted in the matter, whatever that Commission itself did in reference to the dam after obtaining its "thorough knowledge" of the available water supply there.

Given enough money and men to make a thing always possible, you are correct in saying that the occurrence was without excuse (as are epidemics and other public calamities as a rule), and that it was bad to build a dam on such a foundation and ten times worse to attempt to use the structure in its weakened and perilous condition after the partial failure of January, 1910, but the odium really falls upon the engineering profession as a whole because of these engineers "with level and transit and tape line and logarithms" who, in their vaunted expertness cause builders who never grudge payment for real service to shy at sky-hooks or their equivalent, and rely all the more on the common sense of their artisans and mechanics.

It does not avail them to rail at those who are at the responsible head of enterprises who are ill advised from other sources; for we know, as Pilate learned when he constructed the public water supply in Jerusalem, that enterprising people must receive the reproaches and abuse of the populace; and to join the crowds of such people who usually do such things is but making matters worse for themselves.

Yours respectfully,

John I. Riegel.

Miller Bldg., Scranton, Pa., Oct. 14, 1911.

Wood Pavement Specifications at Vancouver, B. C.

Sir: Referring to the paper of Mr. C. H. Mohler, on "Failures of Wood Block Paving in Chicago," published in Engineering News, of Sept. 28, 1911, I would state that there are in this city (Vancouver) to-day a number of miles of creosoted block pavement which has not developed any of the faults set forth by Mr. Mohler.

The accompanying specification for wood paving, in successful use here for the past ten years, was inaugurated by Colonel T. H. Tracy, formerly City Engineer here.

Templet strips ⅝-in. in depth and double handled wide wooden scrapers are used to get a perfect cushion surface. The tie rod in 8-in. T-rails is 5 ins. below the top of the rails and there is no trouble in that respect. The full standard complement of ties are now used on a 6-in. concrete base; then the ties and rails are embedded in concrete to 3½ ins. on the rail, leaving 4½ ins. for paving, chamfered brick are inside for flange space and chamfered wood blocks fit flush against the rails outside. This is called slab construction and seems quite efficient.

One advantage lies in the fact that it is quiet. Formerly the ties were spaced 5 ft. apart and the rail was embedded in concrete but this proved very noisy. The pounding and vibration of the rails disrupted some of the tracks, but not badly, however. This was overcome, as stated above, by laying the full standard complement of ties so as to absorb the vibration of the rails. There is not a single instance of disruption at manholes in ten years.

Yours truly,

Dominion Creosoting Company, Ltd.,
W. H. Harvey, President and Manager.

Vancouver, B. C., Oct. 4, 1911.

Specifications for Paving with Dominion Creosoted Wood Blocks at Vancouver, B. C.

GRADE.—The roadway shall be excavated and graded to a depth of the finished pavement, say 11 ins. deep. Any soft places shall be dug out and refilled with sound earth and stone or other suitable material as the City Engineer may direct. The finished grade shall be smooth and even with the surface of the proposed pavement.

CONCRETE.—Upon the finished grade shall be placed a layer of concrete 6 ins. thick, evenly laid and well tamped to a smooth surface, the contour and crown to be determined by the City Engineer. Careful provision shall be made in this surface for inclines to catch-basins. The concrete shall consist of 1 part cement, 3 parts clean, sharp sand, and 5 parts washed and screened gravel or broken stone thoroughly incorporated.

CUSHION.—When the concrete base has sufficiently set, a dry mortar of 1 part cement to 3 parts clean sand shall be evenly spread over the surface of the concrete base to the depth of ½-in., all inequalities filled to a smooth surface, and, as the placing of the paving blocks proceeds, the dry layer of mortar shall be sprinkled ahead of the block laying with sufficient water.

PAVING BLOCKS.—The paving blocks shall be of Douglas fir accurately cut to dimensions, the plank having been run through a planer to ensure even thickness. The blocks shall be free of pitch and shakes and of sound live timber. The blocks to be treated with approved creosote under pressure until they have absorbed the full quantity of oil as specified by the Engineer.

The paving blocks to be — ins. deep, 4 ins. wide and from 4 to 9 ins. in length.

EXPANSION JOINTS.—A space of about 1 in. wide is to be left between the paving blocks and the curb to be filled with clay or pitch.

FINISHING.—When the paving blocks have been laid on the mortar base in sufficient area and closely driven together longitudinally of the street, and laterally, less tightly, they shall be rolled with a heavy hand roller to a footing in the wet mortar, and any uneven blocks shall be lifted and replaced uniform with the surface.

SURFACING.—The surface of the paving blocks shall be swept clean and the whole surface floated and refloated until all interstices are uniformly filled with a hot flux of coal tar paving pitch, leaving a finish of it upon the surface to retain gravel. The surface shall then be covered with a layer of fine gravel or granite screenings.

Tests of Corrosion of Metal Sheets in a Railway Tunnel.

Sir: In your issue of Aug. 3, 1911, you published an abstract from a paper presented by the writer to the American Society for Testing Materials entitled "Some Tests of the Rate of Corrosion of Metals Exposed in a Gaseous Atmosphere." There were some errors in the original paper which were followed in your abstract and which the writer desires to correct. These refer to the third series of tests and are due to the fact that some of the metals given in the list of relative order of resistance, namely Nos. 2, 5, 8 and 11, were exposed only 42 days whereas the balance were exposed 58 days as stated. The losses in weight shown for these metals were not compensated for the difference in time of exposure, and when such compensation is made the relative order of resistance is somewhat changed and some of the statements relative thereto should be modified in accordance. This error has been corrected for the publication of the paper in the Proceedings of the American Society for Testing Materials.

The second period of exposure of the tunnel tests of the third series having been completed and the results determined, it seems somewhat due to your readers, in view of the error above mentioned, to present the new results herewith. The second exposure was for a period of 60 days for all plates. The relative order of resistance of the various metals for the combined period of 118 days (102 days for Nos. 6, 9, 10 and 11 in the table following, but with results increased in proper ratio for comparison) was as follows:

RESULTS OF 118 DAYS' EXPOSURE OF METAL PLATES IN RAILWAY TUNNEL.—A. W. CARPENTER.

Average loss, grams, per sq. in.:

1.	Lead-coated, galvanized steel sheets (2)	0.121
2.	Special "A" iron sheets, plain (2)	0.168
3.	Special "B" iron sheets, plain (2)	0.170
4.	Wrought iron sheet, plain, (1)	0.211
5.	Special "A" iron sheet, galvanized (1)	0.214
6.	Open-hearth steel angles, plain, (2)	0.237*
7.	Special "B" iron sheets, galvanized (1)	0.246
8.	Open-hearth soft steel sheets (2)	0.267
9.	Open-hearth steel bars, plain (2)	0.278*
10.	Bessemer steel angles, plain (2)	0.285*
11.	Bessemer steel bars, plain (2)	0.305*
12.	Special non-ferric metal sheet, plain (1)	0.421

The figures in parentheses give the number of specimens.

The figures marked with asterisk were derived by multiplying the total loss in the two exposures (42 and 60 days) in each case by the fraction 118/102, in the endeavor to put the results on a properly comparative basis with the losses of the specimens exposed 58 and 60 days (188 days total).

The calculated rate of corrosion per annum for the plain ferric metals, measured by loss in thickness, assuming a uniform rate, from the above, would vary from 0.004-in to 0.007-in. per surface.

A. W. Carpenter,
Engineer of Structures, N. Y. C. & H. R. R.

Grand Central Terminal, New York City, Oct. 2, 1911.

Why Not Purify the Passaic Valley Sewage and Discharge It Into Newark Bay?

Sir: The editorial comment in your issue of Sept. 14, 1911, upon the proposed compromise in the Passaic Valley-New York Harbor sewage-disposal litigation raises the question, why bring the Passaic Valley sewage into New York Bay? The argument for discharge at Robbin's Reef seems to be based on the assumption that it will cost less to do that than it will to discharge sewage into Newark Bay, including with the latter a higher degree of purification than would be required were the sewage discharged into New York Bay. Personally I am of the opinion that this is not true and this opinion is based upon intimate knowledge of the physical conditions and close attention to the Passaic Valley trunk sewer proposition since its inception. The following facts must be borne in mind:

(1) The trunk sewer plan was evolved hurriedly in 1897, fourteen years ago, and since that time sewage purification has made much progress.

(2) While the condition of the Passaic River at Newark is deplorable, the foulness has never progressed down Newark Bay further than the Lehigh Valley Railroad bridge and the researches of the Metropolitan Sewerage Commission show clearly that at the present time the waters of Lower Newark Bay and Kill von Kull are less polluted than the waters of New York Bay.

(3) The trunk sewer plans call for a tunnel under Newark Bay and New York Bay more than five miles in length, mostly under water, at a depth of fifty feet, or more, and through material, the nature of which is not well known, but which I believe includes at least two reefs of trap rock or serpentine, some sandstone and some mud. This tunnel is 12 ft. in diameter and the cost of this part of the work is not likely to be less than $6,000,000.

(4) The State of New Jersey has already agreed with the U. S. Government to purify the sewage to a material extent, which will require probably two pumpings of the sewage and the construction of considerable settling basins, screen chambers, etc.

(5) I find from investigation that all that New York is now asking for in addition is not that the degree of purification offered the Government shall be modified, but simply that the terms of the agreement shall be made more definite in order to avoid future disputes.

The foregoing statement sets forth facts which I have been at pains to correctly ascertain and which must be kept in view in passing upon the merits of this controversy.

Since New Jersey must already purify to a considerable extent, let us consider whether or not it will be cheaper to carry this purification a little farther, empty the purified effluent into

Newark Bay, and eliminate the $6,000,000 invested in the long tunnel under the bays.

Bearing in mind the rapid advance in public opinion, antagonistic to the discharge of crude sewage into our enclosed tidal waters, this large investment in an outfall sewer may prove to be a total loss within a very short period owing to the possibility that a high degree of purification will ultimately be required. We therefore need consider only the immediate discharge of practically 150,000,000 gals. of sewage daily, as the ultimate 300,000,000 gals. may never be reached. To increase the sedimentation tanks sufficiently to allow for a detention of six hours is not likely to add more than $400,000 to the cost of these works. Deducting this from the $6,000,000-cost of the tunnel, leaves $5,600,000 possible saving if the purified sewage is discharged into Newark Bay. Allowing only 5% for interest, depreciation and maintenance of the tunnel, this represents an annual expenditure of $280,000. As we have to handle 54,750,000,000 gals. of sewage yearly, it is apparent, therefore, that we can spend more than $5 per million gallons in treatment of the sewage before purification becomes as expensive as the outfall tunnel. Personally I do not believe that more than 60% purification is necessary to enable this sewage to be discharged into Newark Bay, and with such purification it can be so discharged with less objectionable results than the proposed discharge into New York Bay at Robbin's Reef.

Three of the New Jersey communities, namely, Orange, East Orange and Montclair, have ascertained that they can thoroughly purify their sewage at very much less expense than will pay their part of the cost of the trunk sewer. I believe that this will prove true of the whole project, and am of the opinion that if the sewage can be purified at the same, or even a slightly greater expense than it can be discharged in a partially purified condition into New York Bay, it is impossible to defend such crude discharge.

Being a native and a resident of the State of New Jersey, I have felt a deep mortification in the attitude of the State, due to its persistent refusal during a long period of years to meet the State of New York in a franker and more generous spirit in the effort toward future limitation of the growing pollution of the harbor. The evidences of this pollution are now confined to certain localities, such as Gowanus Canal and Bay, Newtown Creek and several other spots about the wharves. From 1885 to 1890, when a warning cry was first raised as to the Passaic River at Newark, the evidences of pollution were not very marked except on close observation, but shortly thereafter the natural processes of purification suddenly broke down and the nuisance became intolerable. With unrestricted pollution, this, in my opinion, is just what is likely to happen in the harbor of New York. If my premises and conclusions as to the comparative expense are correct, then the present position of the State of New Jersey is entirely indefensible.

"Jerseyman."

Oct. 9, 1911.

[If money can be saved by cutting out the tunnel from Newark Bay to New York Bay could not still more be saved by cutting out the trunk sewer entirely, and building independent sewage purification works for each community, or in some cases for small groups of communities?

As we pointed out in the course of a lengthy editorial discussion in our issue of Feb. 23, 1911, the conditions governing sewage disposal in general and in the Passaic Valley in particular have changed radically since the inception of the Passaic Valley project, fifteen or more years ago. We also urged that these changed conditions demanded a re-study of the whole problem and suggested that the result of such a study would very likely be a recommendation for a number of independent sewage treatment works, and the abandonment of the trunk sewer plan.

The original trunk sewer project was based on the supposition that by carrying it out purification would be unnecessary, at least for years to come, and that the untreated sewage could be discharged into Newark Bay. Popular and political opposition to this plan having developed, the extension of the trunk sewer to New York Bay was proposed and the proposal was adopted, the basic idea still being disposal by dilution, or the avoidance of the cost of constructing and operating purification works. Since then, first one then another degree of purification has been insisted on and adopted, and, regardless of the merits of the case, it is not certain that the end has yet been reached.

The veriest amateur in sewage disposal can see that each additional sewage purification requirement tacked on to the trunk sewer plan lessens the reason for building a trunk sewer at all, and increases the reasons for independent disposal works, near the points of origin of the sewage. Whether these added purification requirements are just or unjust is quite another matter. The only point we are now trying to make is that if the Passaic Valley project is to be reconsidered now comparative estimates should not stop with the elimination of the tunnel to Robbin's Reef, but should include the elimination of the whole trunk sewer between Paterson and Newark, including, of course, the cost of necessary sewage purification works for various communities, singly and in groups.—Ed.]

Notes and Queries.

J. F. B., Medina, N. Y., sends the following clipping from the "People's Column" of the "Buffalo Times":

Pressure on a Dam.

Editor People's Column:

I was talking with a man about this dam breaking away at Austin, and I said, "there must be an awful pressure on a dam with a mile and a half of water pressing against it." He said there was no more pressure on the dam, with a mile and a half of water against it, than with ten or twelve feet of water against it. A. H.

Mayville, Sept. 9.

The man who claims that ten or twelve feet of water exerts as much pressure against a dam as a mile and a half of water does not know what he is talking about. The larger the volume of water, the greater the pressure. There are some people so argumentative that they will dispute any proposition when both the laws of physics and common sense are against them.—Editor.

"If the blind lead the blind, they shall both fall into the ditch together."

Annual Convention of the American Electric Railway Associations.

The annual convention of the American Electric Railway Association and its allied bodies, the American Electric Railway Engineering, Accountants', Claim Agents', and Transportation and Traffic Associations, was held at Atlantic City, N. J., Oct. 9 to 13. There was also the annual assemblage of the affiliated American Electric Railway Manufacturers' Association and a huge exhibit of nearly every conceivable device and material, of service in electric railroading. The total registration of the convention was about 3,700. The following officers were elected for the coming year:

AMERICAN ASSOCIATION.

President, Mr. T. N. McCarter, Public Service Ry., Newark, N. J.

First Vice-President, Mr. G. H. Harries, Washington Ry. & Electric Co., Washington, D. C.

Second Vice-President, Mr. C. N. Black, United R. R's., San Francisco, Cal.

Third Vice-President, Mr. C. L. Allen, Syracuse Rapid Transit Ry., Syracuse, N. Y.

Fourth Vice-President, Mr. C. L. Henry, Indianapolis and Cincinnati Traction Co., Indianapolis, Ind.

ENGINEERING ASSOCIATION.

President, Mr. E. O. Ackerman, Columbus Ry. & Light Co., Columbus, Ohio.

First Vice-President, Mr. Martin Schreiser, Public Service Ry., Newark, N. J.

Second Vice-President, Mr. L. P. Crecelius, Cleveland Ry. Co., Cleveland, Ohio.

Third Vice-President, Mr. John Lindall, Boston Elevated Ry. Co., Boston, Mass.

Secretary-Treasurer, Mr. Norman Litchfield, Interboro Rapid Transit Co., New York City.

ACCOUNTANTS' ASSOCIATION.

President, Mr. P. S. Young, Public Service Ry., Newark, N. J.

First Vice-President, Mr. L. T. Hixson, Terre Haute, Indianapolis & Eastern Traction Co., Indianapolis, Ind.

Second Vice-President, Mr. E. M. White, Coney Island & Brooklyn R. R., Brooklyn, N. Y.

Third Vice-President, Mr. N. E. Stubbs, United Ry. & Electric Co., Baltimore, Md.

Secretary-Treasurer, Mr. H. E. Weeks, Tri-City Ry., Davenport, Iowa.

CLAIM AGENTS' ASSOCIATION.

President, Mr. H. K. Bennett, Fitchburg & Leominster Street Ry., Fitchburg, Mass.

First Vice-President, C. A. Arnott, Birmingham Ry., Light & Power Co., Birmingham, Ala.

Second Vice-President, Mr. R. H. Schoenen, Lehigh Valley Transit Co., Allentown, Pa.

Third Vice-President, Mr. W. F. Weh, Cleveland Electric Ry., Cleveland, Ohio.

Secretary-Treasurer, Mr. B. B. Davis, Columbus Ry. & Light Co., Columbus, Ohio.

TRANSPORTATION AND TRAFFIC ASSOCIATION.

President, Mr. J. N. Shannahan, J. G. White & Co., New York City.

First Vice-President, Mr. Dana Stevens, Cincinnati Traction Co., Cincinnati, Ohio.

Second Vice-President, Mr. D. A. Hegarty, New Orleans Ry. and Light Co., New Orleans, La.

Third Vice-President, Mr. M. C. Brush, Boston Elevated Ry., Boston, Mass.

Secretary-Treasurer, Mr. H. C. Donecker, Secretary American Electric Ry. Assoc., New York City.

Meetings of the American Association.

The meetings of the American Electric Railway Association, opened on the afternoon of the second convention day and continued for three days. The meetings of the subsidiary associations were held in the mornings so that the delegates could attend the afternoon meetings also, but with four-hour morning sessions and a 30-minute interval for lunch this was not easy. The meetings, except for the opening one, were "executive sessions" which discouraged the attendance of all not directly delegated by member companies. The Association permitted the publication of approved abstracts of some addresses and discussions in the "Convention Daily."

PRESIDENT'S ADDRESS.—The address of the President, Mr. A. W. Brady, of Anderson, Ind., reviewed the activities of the parent and allied associations and presented his interpretation of economic and engineering developments affecting the electric-railway industry.

Among the noteworthy association works was the cooperation of the Accountants' Association with the Interstate Commerce Commission in answering all enquiries on electric-road accounting. This sub-association also has under way a study of the life of physical property of electric railways, the results of which are not complete. Another important activity shown was in the insurance bureau recently organized with Mr. H. N. Staats, of Cleveland, as expert. The compilation of statistics to show the actual relation between premiums and losses paid had already led to widespread rate reductions.

Mr. Brady seemed to lament the powers of compulsion which public-service commissions possess, especially in view of the feeling that some commissioners were not over-wise or unaffected by partisan politics. He believed that the interference of a commission beyond defining "adequate service" and "reasonable rates" was an invasion of rights which led only to irresponsibility. He discussed at length the "popular beliefs" that returns on public-utility investments should be limited and capitalization reduced toward reproduction value. Both of these beliefs he would combat by explaining the burdens of maintenance and operation, of depreciation and amortization, and of keeping the service up to the public demands. He would try to secure a more liberally disposed public by a campaign of education through the member companies and by increasing the membership until it occupied a commanding position in the field.

SIZE OF THE ASSOCIATION.—The report of the Secretary-Treasurer, Mr. H. C. Donecker, of New York City, showed a membership of 365 companies (representing about 70% of the total electric-railway mileage in North America) and 1,200 associates. The receipts amounted to $43,353, and the expenses to $40,289.

PUBLIC RELATIONS.—The report of the Committee on Public Relations suggested that some

one experienced in publicity work should prepare for wide circulation a series of articles on the various phases of electric-railway operation.

In the discussion, Mr. J. H. McGraw, of the McGraw Publishing Co., New York City, spoke at length on the indifference of the general public to the private side of electric railroading. He stated that while railway development had been great, it had been accompanied by poorer public relations except in notable instances, where the benefits of proper publicity were evident. He advocated real publicity and an endeavor to extend courtesy and assistance to the newspaper men. He believed in publishing detailed statements of principal classes of expenses and discussing in the papers the local problems of rush-hour traffic, routing, transfer abuses, etc. A physical valuation was recommended, and an analysis of capitalization to eliminate indefensible charges and items that should be written off as a good policy.

Mr. P. S. Arkwright, of Atlanta, Ga., said that the public demanded the best service of his company, but was very responsive to liberal treatment. He regarded it as a matter of course that a street railway had to give good service, but he did not think that the company should expect particular favor from the public merely because it imposed reasonable rates. It could expect to create a public liking for the road if it gave the public more than it was entitled to demand. It should give good service, keep its tracks in good condition, its cars clean and well painted, its men neat and courteous, merely to earn its fares; it had to go beyond that by contributing to legitimate enterprises, by extending its lines ahead of the growth of a city, and by making the car service just a little more frequent than the authorities could insist on. He believed that a company was always asking favors in regard to rush-hour troubles, new franchises, restricted journeys or transfers, so that, to secure generous treatment, it must itself treat the public generously.

EDUCATION.—The Committee on Education, through Prof. H. H. Norris, of Cornell University, chairman, described a correspondence plan which had been tried this year for young mechanics. Briefly, it consisted of assigning a topic for report, and questions to be answered, to force a close observation of daily work. The theory of construction was gradually led up to. Five concerns, the Boston & Northern, Boston Elevated, Brooklyn Rapid Transit, Indiana Union Traction, and Public Service Railway companies, cooperated at their own expense, each company selecting five men for the courses. The boys were supplied at half-cost with elementary reference books and with free trade literature, report books, etc. The results were so promising that it was recommended that the course be maintained for 100 students next year.

STUDENT THESES.—The Committee on Brill Prize reported the winners of the 1911 contest for prizes offered by the J. G. Brill Co., for the best student thesis on "Design of a Prepayment Car for City Service." The first prize of $250 went to Mr. A. H. Packer, Armour Institute of Technology; the second prize of $150 was given to Mr. C. F. Clise, Sheffield Scientific School of Yale University; the third prize, $100, was received by Mr. H. S. Badgley, University of Arkansas. As only five theses were received this year, the company decided to discontinue these contests.

RAILWAY DICTIONARY.—The committee appointed to supervise the preparation of the Electric Railway Dictionary, published by the McGraw Publishing Co., New York City, reported the completion of the work and recommended that the terms and names therein contained should become the standard of the industry.

TAXATION.—The Committee on Taxation Matters submitted a digest of the various state tax laws for nearly all important states. The committee quoted the U. S. Commissioner of Corporations, from whom they received great assistance, as follows:

> The taxation of individuals is substantially the same throughout New England. Corporate taxation, on the other hand, shows wide diversity, both in theory and practice. Individuals are taxed on property. Corporations are taxed on property, or on income, or on a combination of both, or on capital stock, either par or market value, or occasionally, as in the case of telegraph and telephone companies, on mileage or number of instruments. Administration ranges from a system highly developed handled centrally by state officials with large powers to no centralized administration whatsoever. Railroads are among the largest taxpayers. Public-service corporations, such as street-railway, telegraph, telephone, express-car, gas and electric companies, are most often brought under special and new systems of taxation. Taxation of public-service corporations on gross receipts is growing in use.

The committee also drew on the U. S. Commissioner's report for various data. For instance it was reported that

> In Maine, practically 49% of the revenue of the state is derived from special taxes upon corporations; in New Hampshire 27%, in Vermont 36%, Rhode Island 40%, Connecticut 84%, New Jersey 92%, Pennsylvania 72%, Delaware 62%, New York and Maryland 32%, District of Columbia 16%, Wisconsin 71%, Ohio 52%, Indiana 19%, Illinois 34% and Michigan 45%.

PROPER BASIS FOR FARES.—The committee on this subject reported that there existed a widespread need of increased fares if adequate service was to be furnished and new capital secured. They found open six ways of increasing returns: (1) eliminating the transfers, (2) charging 1, 2 or 3 cts. for transfers, (3) increasing the prevalent 5-ct. rate, (4) establishment of straight zone system without transfers, (5) establishing such a zone system as required a 5-ct. fare from an outlying to a central district, but a 10-ct. fare across the central (business) district to another outlying zone, (6) establishing a zone system where 5 cts. would be charged within one district and 3 cts. extra into another. The last scheme was favored.

U. S. MAIL.—The Committee on Compensation for Carrying U. S. Mail reported the results of two conferences, one with the committee of the American Railway Association on railway mail, and the other with the Post Office Department. The short-line steam roads had decided that there was such divergence from electric operation that the only cooperation could be in the interchange of data. The Committee had presented the desired rates to the Post Office officials but had not secured action as yet. The desired rates were those reported a year ago—3 cts. per car mile for one to three pouches handled on passenger cars and 1 ct. per pouch per mile for additional pouches; 1½ cts. per linear foot per car mile for railway post-office service on city lines; for mail service on interurban lines, the maximum compensation on similar steam lines.

FEDERAL RELATIONS. — This committee found only continual progress toward absolute Federal control of corporations and persons doing interstate business. The report described pending bills on Federal incorporation, physical valuations, restraint of monopolies, workmen's compensation, arbitration, labor, rates, safety devices, etc. Members were urged "to take deep practical interest, local and general, in tentative legislation by Congress."

INSURANCE.—The Committee on Insurance in reviewing the condition of this field presented the table below as showing what benefit has been secured by study of rates and losses.

The committee felt that the reduction of losses shown was more notable than the reduction of rates, but that the losses should be reduced still more. The committee related how Mr. H. N. Staats, of Cleveland, had been appointed as insurance expert without salary, but receiving compensation from those companies employing his services.

There were several noteworthy addresses, at the meetings of the American Association, on the larger problems of electric railroading.

THE INTERURBAN ROAD.—Mr. C. L. Henry, President of the Indianapolis & Cincinnati Traction Co., in "The Interurban," sketched the developments in electric traction which led up to the interurban road, and reminded the members of the burdens which the interurban road had to carry—expensive right-of-way and track, heavy equipment, signal systems, etc. He had found that towns objected to running freight cars through the streets or unloading freight and passengers except at expensive terminals while allowing teamsters and drovers unlimited occupation. The rates of fare were being limited to 2 cts. per mile and the companies were being forced to carry baggage free and to assume the liability of compensation of accidents to negligent workmen. Mr. Henry urged the necessity of reminding public officials and the whole public generally that it is unfair to place burden after burden on the roads and that in the end the riders must pay or the road could not exist. He urged education against accidents and against extortionate claims for injuries and believed that tax burdens would be reduced when this handicap to cheap and convenient service was realized.

EFFECT OF RAILWAY GROWTH ON PROPERTY.—Gen. G. H. Harries, Washington Railway and Electric Co., Washington, D. C., in an address, "The Effect of Electric Railway Operation on Taxable City Property," set forth in some detail how the development of electric-railway lines in the District of Columbia had added at least $46,000,000 to land values and was responsible for a steady increase which in a large part of the territory exceeds 100% annually. Meanwhile, he claimed, the roads have accumulated a deficit of over a million dollars, with further deficits in prospect.

WELFARE WORK.—"Measures for Welfare of Employees" was the title of a paper by Mr. D. T. Pierce, of New York City. He believed that the experience of European companies and the general tendency of legislation here warned the employer that if he did not take the initiative in furnishing sick relief, pensions and insurance these would be forced on him. Yet success in all such plans depended greatly on the spirit in which they were approached. To lessen labor troubles, the plans must not savor of pure expediency but must show a real desire to improve conditions of employment. He believed the employee would soon find out the true spirit in either case. While there might be a slight money value to the employer of results from these welfare plans, yet he must look only to holding the services of a better class of men and creating a spirit of attachment which was manifest in loyal conscientious service. The only available data were from associations to which the members contributed dues. The average death benefit shown by such (electric-railway) associations was $212, and the average sick benefit $6.50 a week. Only about 50% of the electric-railway employees now take advantage of such associations. If the company applied a plan for all employees the benefits were given to twice as many as now enjoy them; if the expenses were borne by the companies some gratitude would be felt toward them and undesirable organization of employees would be retarded though not prevented. One large public-service corporation was reported as making an annual appropriation of $50,000 on a system of sickness and death benefits and pensions for 8,500 employees, which indicated that $5.50 per person per year would be needed for any such railway system. The loaning of small sums to employees in time of emergency was recommended to keep the men out of the hands of "loan sharks." A "welfare secretary" was also found a desirable connecting link between the men and the executive officers who should control the welfare work.

MISCELLANEOUS.—"The Toledo Street Railway Situation" was described by Mr. A. E.

	1905	1907.	1908.	1910.
Insurance Carried	$848,000,000 (Est.)	$342,893,377	$54,928,494	$192,364,228
Premiums	6,049,641	3,724,835	446,861	1,354,068
Losses	1,971,806	2,152,696	8,821	261,982
Recoveries	1,673,336	1,587,623	7,264	182,738
Ratio of losses to premiums	32.59%	57.7%	1.97%	19.3%
Ratio of recoveries to premiums	27.66%	42.6%	1.63%	13.5%
Premiums per $100 of insurance	$1.25	$1.08	81 cts.	70 cts.
Losses per $100 of insurance	41 cts.	63 cts.	1.6 cts.	13.6 cts.
Recoveries per $100 of insurance	35 cts.	46 cts.	1.3 cts.	9.5 cts.

Lang, President of the Toledo Railways & Light Co. He traced the growth of the early horse railways in Toledo and the competition of the early electric roads which led to duplication and unsound routing, etc. Finally, in 1896, all the lines passed under a single ownership and the new company sought to make a new franchise to secure uniform terms and conditions. The grant was refused and the company continued to operate under the disadvantages of making no new extensions, etc. A second application was made in 1904, but became engulfed in politics and was refused. Since then, 3-ct. fares have been political issues and no grants even for switches, curves, etc., have been secured. In 1908, the railway officials attempted to lift the embargo, but nothing could be done until the Cleveland 3-ct. fare negotiations had been completed. In 1910, the city officials were requested again to take up the renewal questions. The city was invited to inspect the books of the company and its consulting accountants did so. Later, at the city's request, an engineering firm made an inventory. Then the Mayor outlined his views of proper relations between city and company and suggested drawing an ordinance embodying them. The company agreed that this was desirable for public discussion at least, but found that the document when issued by the city's solicitor had so many burdensome conditions that the road could not pay operating expenses alone, even on 10 or 15-ct. fares. Finally several meetings were held for discussion and the matter progressed up to the point of fixing a valuation of the property. A board of three assessors was suggested and the city appointed Prof. E. W. Bemis as one, expressing a desire to have a Federal judge as the third. The company was not satisfied that these men wert competent and failed to appoint the second. At present, the company faces ejectment and rental suits for the use of the streets; the public mind, according to Mr. Lang, is poisoned by abuse of corporations so that many office holders cannot defend the company. The hope of settlement lies in enlisting the manufacturing, real estate and banking interests and the energetic young business men generally.

Mr. J. V. Davies, Chief Engineer, Hudson & Manhattan R. R., New York City, in a paper, "The Hudson River Tunnels," described some of the features affecting the carrying capacity of this tunnel railway—points like cars, track construction, signal system, ventilation and repair facilities.

There was no general discussion on Mr. Davies' paper, but Mr. T. N. McCarter, of Newark, N. J., in moving a vote of thanks, took the opportunity to bring to attention "the ridiculous proposition, now so popular," that men like Messrs. McAdoo, Davies and Jacobs should give years of their lives to the construction of an engineering project like the Hudson Tunnels and then be allowed to have it earn only a mere interest return.

The paper, "Electric Railway Securities," by Mr. J. G. Cannon, President of the Fourth National Bank of New York City, and "Physical Valuations," by Mr. O. T. Crosby, Wilmington & Philadelphia Traction Co., of Wilmington, Del., were also presented.

Meetings of the Engineering Association.

The meetings of the Engineering Association started on the afternoon of the opening day and continued with one long session a day throughout the entire period.

PRESIDENT'S ADDRESS.—The address of the President, Mr. W. J. Harvie, of Utica, N. Y., briefly reviewed the activities of the association between conventions and commended the work of the committees whose work was seen on the program to be carried out.

ASSOCIATION WORK.—The report of the Executive Committee, presented by the Secretary-Treasurer, Mr. Norman Litchfield, of New York City, furnished the details of the year's work. Letter ballots had been sent out for the approval of the standards recommended by the 1910 convention. These were for a No. 0000 grooved trolley wire and a copper wire table. These had been generally approved and two items had been accepted as "recommended practice,"(1) a high T-tail for heaviest service, and (2) a high T-rail for light service. It was found on inquiry that half the companies were opposed to continuing the annual "question box" and half strongly in favor of it. Therefore, it appeared again this year. Arrangements had been completed for cooperation with the American Society for Testing Materials; sub-committees had been appointed to act in the matters of (1) heat-treated axles, (2) equipment and heavy traction, (3) rolled-steel wheels and wrought iron, (4) steel in rails, (5) way matters. It was reported that the annual expenditures of the Engineering Association had amounted to $6,659, of which $3,173 was for publication of the 1910 proceedings.

EDUCATION.—The Committee on Education of Engineering Apprentices was appointed this year and instructed to investigate the question of a desirable system for the government and instruction of regular apprentices in the mechanical trades in connection with electric railways. The committee, feeling that there never had existed a greater necessity for proper training or American boys in the mechanical trades than now, limited itself to the investigation of that class of apprentices connected with the maintenance of rolling stock. A code of rules was presented as a general basis to be used with such revisions as were necessary under individual circumstances of operation. The rules provided, in general, that the apprentice should be between the ages of 15 and 19 and that he must have received a common-school education. The term of service was placed at from three to five years. The committee did not consider it advisable to go into the various characters of trades like machinist, blacksmith, carbuilder, electrician, painter, etc., but outlined rules for the apprentice course for the training of such general mechanics for the maintenance of rolling-stock equipment. The apprentice was to start in the tool room, store room or shop office where he would stay four months. The rest of his total time was to be distributed as follows: helper in general machine shop, six months; helper in blacksmith's shop, three months; small work in blacksmith's shop, three months; machine shop, six months; coach shop, four months; pipe and air-brake shop, four months; armature and field repairs, six months; overhauling trucks and motors, six months; control apparatus and general testing, six months. A general scale of wages was quoted as follows: First year, 10 cts. per hr.; second year, 12½ cts. per hr.; third year, 15 cts. per hr.; fourth year, 17½ cts per hr.

In the discussion, a letter was read from Mr. E. D. Dreyfus calling attention to the similarity between the proposed courses and those laid out for shop apprentices of the Westinghouse Machine Co. He believed that the proposed courses would produce better men if, in addition to the shop works, the boys were brought into contact with the office organization to get an idea of the necessity of certain methods. Mr. Farley Osgood, of Newark, N. J., and others emphasized the need of instructing the prospective mechanics, in the company's time, into the "why" behind the "how" of such courses as outlined, Mr. William Roberts, of Akron, Ohio, recalled the benefits of correspondence and Y. M. C. A. courses in the training of young mechanics.

POWER DISTRIBUTION.—The Committee on Power Distribution submitted outline drafts of specifications, (1) for three-conductor, high-tension, paper-insulated, lead-covered cables; (2) single-conductor high-tension paper-insulated, lead-covered cables; (3) 30% rubber compound; (4) standard grooved trolley wire in sizes other than No. 0000; (5) for No. 00 round hard-drawn trolley wire; (6) overhead crossings of electric-light and power-transmission lines. A paper was also submitted on concrete, latticed and tubular poles, and the terms "cable" and "strand" were defined. The specifications for overhead crossings were contained in a joint report of the American Electric Railway Engineering Association, National Electric Light Association, American Institute of Electrical Engineers, Association of Railway Telegraph Superintendents, American Railway Engineering Association.

The following definitions were offered as representing terms as commonly used by the electric-railway operating engineer.

A "strand" is an individual wire of a group of symmetrically assembled wires which form a conductor. A "conductor" is either a solid wire or a group of wires assembled symmetrically as a unit. A "cable" may be defined as one stranded conductor or a group of conductors either solid or stranded assembled as a mechanical unit.

The specifications for cables and trolley wire and for the overhead crossings were approved and recommended to the committee on standards for adoption. The specifications for 30% Para rubber compound were held over because of disagreements on some sections—some of the members felt that the requirements should be greatly stiffened.

The paper on reinforced-concrete poles aroused a lively interest and showed that these developments were being closely watched. Mr. R. D. Coombs, Consulting Engineer, New York City, believed that the cost figures reported by the Committee were too conservative the use of the concrete poles, not being an economy until the price of wood poles should rise more. He had built a few poles about comparable with a good chestnut pole for 12 wires, at a cost of about $10 each. Mr. L. P. Crecelius, of Cleveland, Ohio, described a type of trolley pole which had been largely used by the Cleveland Ry. Co. This was 28 ft. long tapering from 10 ins. at the butt to 5.5 ins. at the top. There were eight twisted steel bars for reinforcing and the cross-arms and collars were of malleable iron. The pole complete weighed 2,200 lbs. and cost $10.71. The subject of electrolytic destruction of such poles was brought up by Mr. Harry Barker, of Engineerings News, New York City, outlining the conditions of railway service that seemed particularly unfavorable. None present gave any information of actual troubles with poles in the field. It was admitted, however, that the chance of insulator troubles in wet weather were great enough to cause either the few amperes to flow, which would result in failure of the pole through localized thermal action, or that the small fraction of an ampere which might cause destruction after a long time through true electrolytic action. As remedies, various members suggested bringing the reinforcement outside the pole for grounding, protecting the butt by an asphalt membrane, etc. It was held that a concrete pole should be regarded as non-insulating and should always be grounded.

HEAVY TRACTION.—The Committee on Heavy Electric Traction this year considered in its report only three subjects, (1) the location and clearances for third-rail working conductors; (2) the location of electric end connections on cars and locomotives; (3) the location of automatic train stops. As a result of conferences with the American Railway Engineering Association, a diagram was prepared showing location and clearance lines which were understood to be satisfactory to all. Such lines have been established as affect the relation of third-rail construction to rolling equipment. The relation to permanent way structures has been left for subsequent consideration. The gage line of the third rail was recommended to be not less than 26 ins. and not more than 27 ins. from the gage line of the track. The contact surface of the third rail was recommended to be not less than 2¾ ins., nor more than 3½, above the plane of the top of the track rails. It was considered impossible at the present to adopt a definite standard for end connections, but it was considered feasible to define certain space at the ends of cars to be reserved for the location of end connections.

In the matter of automatic train stops, the committee felt that their use as a protection against failure to obey a signal was getting to be greater and that it was advisable to make certain suggestions regarding the proper location of trip arms along the track and contact devices on the cars, which may be regarded as recommended practice until standards become advisable. The recommended location is that adopted for the Tunnel Extension of the Pennsylvania R. R. and by the Hudson & Manhattan R. R. Co.

In the discussion a letter from Mr. E. B. Katte, Chief Engineer of Electric Traction, New York Central & Hudson River R. R., commended the standardization of third-rail clearances, but remarked that his company could not employ the clearances recommended for automatic stops on account of interference with steam equipment.

The heat treatment for axles, etc., received plenty of discussion. Mr. F. R. Phillips, of the Pittsburgh Ry. Co., criticized the specifications as being too vague as regards the methods of treatment. He also believed that the same properties could be obtained without heat treatment. Representatives of several steel mills, however, reported that there was no certainty of securing the desired properties, as disclosed by the prescribed tests, without very careful heat treatment. Various members commended the specifications for their general character, holding that they should not restrict the manufacturers after they had fixed the general treatment and results to be secured. The meeting recommended the specifications to the Standards Committee for adoption as standard.

BLOCK SIGNALS.—The Committee on Block Signals presented a voluminous report of 124 pages with two large inset tables. The committee had been instructed to study and report, (1) on various systems of signaling and dispatching in use in the country, (2) on the essential requisites of a proper system, (3) on automatic block and manual signaling, and (4) on the principles which should provide a maximum of safety in electric-railway operation. The committee met with various signal engineers and the representatives of signal manufacturing companies. In preparing the report the committee endeavored to collect such data as would be of educational benefit to a number of companies. There was a historic outline of signaling for electric railways and a discussion of the peculiar necessity of adequate signals for electric railways. There were data sheets for 50 companies showing all the data securable on the operating conditions which affect signaling and on the signaling and dispatching equipment itself. There was included also a digest of commission rulings and laws on signaling, with a list of block signals to be installed during 1911 and descriptions of the various types of apparatus furnished by the various signal manufacturers. The committee was unable to report definite conclusions on account of the continual development of new apparatus and methods. It left for a future committee the task of studying present systems for the presentation of recommendations along various lines.

The discussion of the report was largely appreciative, though much was said about certain practices which have been developed. Mr. H. S. Balliet, New York Central & Hudson River R. R., recommended standardizing the upper-quadrant positions for semaphore arms, the steam-road men taking the upper right-hand quadrant and electric-road men the upper left-hand one where they could not agree. He had found it difficult properly to locate light signals for the center tracks of the Park Ave. tunnel (New York City) except by using 16-c. p. lamps and 8-in. lenses. On the outer tracks, which were darker, the light signals with 3-c. p. lamp could be read 2,500 ft. For open work, he favored semaphores, but thought that light indications could be developed for interurban service. There were great advantages with lamps in operating mechanism and maintenance, and in the end it was the best maintained signals that gave best service. Mr. Charles Morrison, Signal Engineer of the New Haven Road, favored the use of semaphores wherever possible and believed that a satisfactory standard design could be secured. There was great need of laying out the circuits so that crossed wires could not give a "proceed" indication. He agreed that the proper maintenance of signal apparatus was all important. The New Haven Road had adopted the center-suspended arm for its whole system as a result of the success with this type in its electric zone where signals were suspended from catenary bridges close to the 11,000-volt trolley wires. He reported that the Woodlawn-Stamford electric section (20 miles of route) required about 120 KW. for operating signals, lamps and track circuits.

SCIENTIFIC MANAGEMENT.—The Joint Committee on Accounting of the Engineering and Accountants' Associations presented first a discussion of so-called "scientific management." The general principles of Mr. F. W. Taylor's methods were briefly presented, the committee stating that a study of what had been accomplished in other industries would be instructive to electric-railway officials and that the accountant and engineer should meet on common ground here. A long bibliography of articles and books on this subject was also presented. The report also reviewed the discussions at the last convention on a similar committee's report and revised in minor ways some of the subdivisions of accounting as related to engineering construction and maintenance.

The discussion on "Efficiency Engineering" was mostly by Mr. Harrington Emerson, of New York, the other speakers commending the work or asking questions to have their doubts dispelled about the workings of the new systems. Mr. Emerson spoke mostly on increasing production through more efficient efforts rather than more strenuous ones. Under these conditions the workman had an easier time with better pay, but more responsibility.

MAINTENANCE ACCOUNTS.—The question, "what constitutes maintenance," was presented by the Accounting Committee, with a review of various commission decisions. The question was answered in various ways. Many of those present, led by Mr. H. G. Stott, Interboro Rapid Transit Co., New York City, included as maintenance all items of expense required to keep the plant up to its initial operating capacity, this left no "depreciation," but only an obsolescence or amortization charge, against operating revenue. Others believed that there was a margin, not properly included as obsolescene, needed to cover that loss in value due to use which no amount of maintenance could prevent. Mr. Harrington Emerson cited his own troubles, in steam-railway work, of finding what maintenance was and what was an extension to come out of capital; he had found the answer to the question in comparing two annual specific inventories which showed the actual value of the property units and how they had been improved, kept up, or allowed to depreciate. Expense items were then intelligently distributed as the last inventory showed. Mr. Charles Hewitt, of Philadelphia, and Mr. W. F. Ham, of Washington, had found a consensus of opinion backed by the work of the Interstate Commerce Commission that whatever expense was incurred to keep the integrity of a property was to be accounted as maintenance and anything that extended or improved a property should be charged against capital. However, it was stated, the theory of such accounting was easy, but the application difficult. If a car had to be replaced, or a new power station built to supplant an old one, their cost ought to be charged to maintenance, but their inclusion there would destroy the comparative value of the statistics. The recommendation of the committee that

> A definition of maintenance that does not include replacements in a system of accounts is incomplete unless the system provides for charging replacements to a "depreciation-reserve" account created by charges to depreciation under operating expenses, in which case the term should include depreciation. . . .

was generally approved.

POWER GENERATION.—The Committee on Power Generation assigned the subjects given it for investigation to different members of the committee, and the report as presented consists of a series of papers by these gentlemen. In outlining developments in the generation of steam, Mr. H. G. Stott largely confined himself to a description of new instruments for measuring the flow of steam from boiler and the amount of coal fed from gravity bunkers. Mr. L. P. Crecelius, of Cleveland, Ohio, reported on the best standard voltage in frequency for three-phase turbo-alternators with reference to size and voltage. He tabulated the relative costs of cables and conduits to determine the most economical voltage for general utility on systems where the power plant was within 50,000 ft. of the substations. His figures indicated that 11,000 volts was the most satisfactory transmission voltage, and this was noted as the limit of good turbo-alternator design. For such alternators directly coupled to turbines with direct electrical connection of the generator to the transmission lines, it was considered advisable to introduce reactance coils to limit the current and the stresses in the generator windings.

A letter was included from the Westinghouse Electric & Mfg. Co. on turbo-generators for 600-volt railway service, of larger than 500-KW. capacity. It was shown that the limitations of design had been reached on account of the speed of the commutator under carbon brushes and of the size of the commutator required for the heavy currents. These limitations of design have led to the development of the geared type in which a Melville-McAlpine mechanical gear (see Eng. News of Oct. 21, 1909) has been interposed between the turbine and the generator to render possible a lower speed of the generator and a higher speed of the turbine. Such sets of 500 and 1,000-KW. capacity are in progress of construction.

Mr. Crecelius also presented the specifications for the purchase of bituminous coal in use by the Cleveland Railway Co., Cleveland, Ohio, and those of the Interboro Rapid Transit Co., of New York City.

In the discussion, Mr. Charles Hewitt described troubles, in banking one end of a double-ended boiler, with smoke in the boiler room. He believed that it would not be found economical to run a boiler at more than 35 or 40% over rated capacity. Mr. H. G. Stott had found no trouble in that way in the large installation which the Interboro company had in New York City. They kept about ¼-in. draft on the banked ends. He showed how the forcing was an economic question; the company could afford to cut efficiency so as to reduce fixed charges, the total cost of annual operation then including (1) daily operating expenses and (2) all fixed charges. In contrast to Mr. Hewitt, he was of the opinion that in a short time it would be practical to run boilers at 300% of normal rating; with good coal and moderate forced draft the efficiency would not drop off more than 5%. The Interboro Company had found no signs of deterioration in boilers used at above rating continuously and they were cleaner, due to rapidity of circulation. In the furnaces proper, there was an increasing cost of maintenance with forcing; that is, in the double-ended boilers it cost 60% more than in the case of single-end furnaces, in which was an economy over two single-ended boilers.

Mr. E. N. Lake, of Stone & Webster, Boston, disagreed with the parts of the report which stated that 11,000 volts was the limiting figure for economical underground transmission and that non-magnetic coils should be used between generators and bus bars rather than transformers. His experience had been that if the added size of duct required for 11,000-volt transmission were taken into account something over 15,000 would be found desirable and then the step-up transformation and inclusion of reactance in the circuit could be secured simultaneously by transformers. Mr. Stott agreed with the committee and, defining "satisfactory service" as "no more than one breakdown per year per 50 miles of cable," believed that no one would secure satisfactory service with over 11,000 volts.

The purchase of coal on specification received considerable discussion; Mr. G. H. Bayne, Pennsylvania Coal & Coke Co., had found two great troubles in such plans, (1) the inability of the chemist and mechanical engineer to agree on proper specifications for a particular plant, and (2) proper sampling. Coal companies, he believed, would be glad to bid under specifications properly prepared; it was desirable first for the engineer to run boiler tests of coals available for a particular plant to determine which had the most desirable steaming qualities. Then true samples of this could be analyzed by the chemist to define characteristics which might

distinguish that desirable coal. As coal was not a manufactured product, reasonable leeway for natural variations should be allowed in the specifications. Several members mentioned the improvement in plant operation which they had secured by coal purchase under specifications.

BUILDINGS.—The Committee on Buildings and Structures having been instructed to consider the topics (1) economical maintenance, (2) proper facilities for employees, and (3) proper installation of fire protection of carhouses and terminals, sent out letters of inquiry to secure a discussion on the most important points under consideration. On account of the broad scope and complicated nature of the subject of economical maintenance, the committee took up only a few questions of greatest importance.

They recommended that the best method of maintenance of structures was systematic repair by the working force of the operating company, and that regular inspections should be made at stated intervals. As to heating systems, the following were recommended: a steam-coil blower system for car houses and car shops except for the paint shop, where direct radiation was advised; for a small shop, direct steam or hot water. The heating of isolated waiting rooms was reported practical only if attended, and then by coal stoves. Large waiting rooms should have steam or hot water systems. Small isolated ticket booths, etc., should have an ordinary electric-car heater.

For roof covering some built-up roofing of felt, pitch and gravel with copper flashings was preferred. Concrete floors were advised for carhouses, car shops, power houses (exclusive of some boiler rooms), toilet and locker rooms, waiting rooms and shelter platforms. The committee recognized the need for including suitable facilities for employees in the construction of carhouses, etc. The principal question advanced was, how far should the company go? The committee suggested that in designing car houses and shops the facilities for comfort and convenience should be laid out ample to secure the highest efficiency of the men. Some games or amusements were recommended, such as pool and billiards, or bowling in some communities. A men's room at the carhouse terminal was necessary where reports could be made out, bulletins posted, and where the men might await orders. An assembly room for entertainments was found growing in favor.

In regard to fire protection, the committee recommended that automatic sprinklers were to be preferred in enclosed places, but that sand pails, chemical extinguishers, water pails and small hose lines should be provided. For open spaces where the heat would not operate automatic sprinklers, universal nozzles on standpipes, standard fire hose and open sprinklers were recommended. It was also advised that the employees be instructed in the location and workings of the various protective appliances. The report carried as appendices a paper on "Economical Maintenance," by Mr. Martin Schreiber, of Newark, N. J.; specifications drawn up for a roof covering by the Milwaukee Electric Railway & Light Co.; a description by Mr. N. W. Boland, of Newark, N. J., of the various facilities provided for employees of the Public Service Railway Co.; a paper on "Automatic Sprinklers," by Mr. C. H. Clark, of Cleveland; a paper by Mr. George H. Pegram, of New York City, on "The Open Yard Sprinkler Equipment of the Interborough Rapid Transit Co., at its 159th St. Storage Yards," and the specifications of the Public Service Ry. for fire protection at its Springfield Ave. (Newark) carhouse.

There was a general attempt, shown in the discussion, to get away from steam heating and to use hot air in barns and shops on account of poor experience with freezing pipes. Roller-lift doors seemed to have given trouble in sticking and troublesome repairs; sliding doors seemed to be preferred over swing on account of decreased cost and longer life.

A large part of the discussion related to fire protection and insurance rates. Mr. C. H. Patton, of the Cleveland Inspection Bureau, in a letter, stated that insurance engineers were not all favorably impressed with the monitor-nozzle and open-sprinkler plans for open car yards. He expected that a committee of the National Fire Protection Association would report on these plans at its next meeting. Mr. H. N. Staats, insurance expert of the American Electric Railway Association, strongly opposed Mr. Patton's opinions, believing that the elevated monitor nozzles offered the best protection for open spaces and that while open sprinklers were good for incipient fires they should be reinforced with monitor nozzles. Six years ago, he said, the proper rates for electric-railway properties were not known, but now the railway people were relying on themselves for studies of the fire hazards and protection, instead of on the insurance companies, they were getting reduced rates. The cost of insurance had come down from some $1.50 per $100 to 73 or 74 cts. This was progress, but it was urged that the hazards of electric-railway properties were no greater than of the properties in the so-called "mill-mutual" insurance companies, where $2,500,000,000 was carried at an average of 10 cts. per $100.

TRACK AND WAY.—The Committee on Way Matters presented four topics: (1) a standard 9-in. girder rail section and suitable mechanical joints; (2) organization and rules for a way department; (3) shop facilities and working equipment of a way department; (4) nosing of cars and its effect on the track. The sub-committee on rail section reviewed the previous reports of the association in the matter and presented a 136-lb. Trilby section which they believed embodied the features of good service and eliminated defects that had developed in older designs. Some of the important features of the proposed standard section are as follows: width of head, 3 ins.; top fillet of head, ¼-in. radius; depth of groove, 1⅝ ins.; width of groove, 2⅛ ins.; angle of groove, 37°; tread, 2⅛ ins.; depth of section, 9 ins.; center of web, ¾-in. from gage line; width of base, 6½ ins. A plane tread was used inclined to the gage, although worn rails showed rounded heads and a tread inclined at some angle to the gage. While it seemed desirable to make the tread a curve, the difficulty of grinding joints and of rolling prevented. The small top fillet of the head was used since worn out rails, where excessive swaying did not exist, showed a small radius corner. The gage side of the head was made a small angle in spite of need of a vertical side, on account of the positive statements of manufacturers that a vertical head could not be rolled, the depth of groove was designed so that the flange touches the bottom when the allowable wear of the tread is reached.

In the matter of organization and rules for a way department, the Committee presented as "recommended practice" a book outlining a plan of organization, general rules for the men and the work of constructing and maintaining the roadway and structures.

The shop equipment of several companies for the way department was studied and the committee made several recommendations for the establishment of independent facilities for this department, with the necessary standard machine and hand tools, but it was recommended that the extensive manufacture of special work should be undertaken generally.

A study of economy in the use of preservatives for timber, looking to the installation of local treating plants, was recommended. The advisability of the use of crane cars, rail grinders, power-driven concrete mixers, etc., was pointed out.

There was a long discussion of the proposed standard rail, the general opinion seeming to be that it was a great advance over previously devised sections. The chief objections seemed to be from the manufacturers. The proposed section was referred back to the future committee since a 7-in. section and guard rails for both 7-in. and 9-in. sections were needed when any standard should be proposed. It was recommended, however, that the principles of design shown should be adhered to.

The proposed book of rules was objected to by some as being too cumbersome compared with the similar rules of the steam roads, but they were referred by the meeting to the Standards Committee for adoption as "recommended practice."

ROLLING STOCK.—The Committee on Equipment studied five subjects: (1) heating and ventilating of cars; (2) design of trucks for light weight; (3) design of trucks for light weight; (4) design of electrical equipment for light weight; (5) standard couplers and control connections for interurban service. The dissertations of the sub-committee on these subjects were included in the report as appendices.

In the study of heating and ventilating of cars, the cardinal virtues of a heater were reviewed and the costs of operation and installation were compared. A surprising result of the study was that the total annual cost for heating (145 days on a 32-ft. car, with the lowest temperature of about zero and the municipal requirement of 50° F., with power costing 1.4 cts. at the trolley and coal $7.75 per ton) with the electric heater was $166.92; with the hot-water heater, $151.56; and with the hot-air heater, $118.18. These figures included repairs, maintenance, interest, depreciation, labor, insurance and cost of hauling with the car. It was pointed out that if the maximum annual load on the power stations came at a time when the heating of the cars was not required, then the electrical heater would make a still better showing, since the cost of power would not include fixed and labor charges and would be reduced to, say, 0.5 ct. instead of 1.4 cts., the actual annual cost then reducing to $68.30 for the electrical heater.

The design of car bodies for light weight was taken up by showing how the weight had been cut 25% by a substitution of recognized engineering methods of structural design for older "rule-of-thumb" and greater use of steel sections. Similarly, in presenting the design of car trucks for lighter weight, it was shown how the use of I-sections for rectangular and the elimination of cast iron had reduced the weight of the different members from 10 to 30%. In reviewing the progress in the design of electrical equipment to secure a lighter weight, the committee showed where forced ventilation of motors and a possibility of a higher working temperature (with the use of heat resisting insulation) had allowed an increase of capacity for given weight. Finally, it was reported that the idea of decreasing the field excitation to secure a higher running speed was promising for motors now being built with auxiliary commutating poles to eliminate the sparking which prevented field control on earlier machines.

It was evident from the discussion that the two most troublesome matters of equipment were couplers for interurban cars and squealing brake shoes. The members found no way of determining buffing and traction stresses and had to design couplers largely by guess. The squealing shoes some members attributed to wet tracks and others to dry. Some believed it was due to action between wheel and rail and others that it came from wheels and shoes. Mr. H. H. Adams, of New York City, reported success by having a pocket of asphalt compound in the brake shoe. Mr. G. L. Fowler, of New York, reported a proposed investigation to locate the seat of the noise and from that the causes, of which he believed there were several.

The test of a thermostatic regulator in connection with electric car heaters was described by Mr. H. H. Adams. Over 50% of the heating current had been saved in addition to the time of men needed to regulate the heaters to accord with temperature changes. Moreover, the thermostat automatically cut off the heating current during peak load, since then the cars were filled with passengers and warm enough from natural heat.

During the discussion of lighter cars, Mr. Norman Litchfield, of the Interboro Rapid Transit Co., gave the result of careful segregation of weight in steel cars of about (71,000 lbs.). It was surprising to note that side frame and sheathing contributed only 14.0% to the total

weight, while the floor frame and floor made up 29.2%, the roof 10.7%, the vestibules 5.5% and miscellaneous small equipment 17.7%. His point was that the importance of weight in side frames had been greatly over-estimated and under-estimated in the matter of miscellaneous equipment.

STANDARD EQUIPMENT.—The Committee on Rules of Procedure for the Committee on Standards outlined a code which described the make-up of the Standards Committee and the way in which subjects should be presented to it, as well as the way in which its recommendations should be brought before the Association. This plan was adopted.

The Committee on Standards reviewed several propositions which had been brought before it to determine their advisability as standards. It was not considered that the time was ripe for the adoption of the standard rolled-steel wheel, since the question was being investigated by a committee of the American Society for Testing Materials. The dimensions proposed were given, however, as "recommended practice." A gage for mounting wheels and a gage for track on curves met the same treatment as the 1910 recommendations for track layouts, and symbols for recording surveys were labeled "recommended practice," as were the specifications for open-hearth steel rails. The only standard passed by the Committee was that of a taper for bore of pinions in the proportions of 1¼-in. diameter to 1 ft. in length.

The findings of the committee were adopted by the meeting except in the matters of the gage for mounting wheels and specifications for wrought-iron bars, which were referred back to the proper committees.

THE QUESTION BOX.—The last report of the convention was on the "Question Box." On account of criticisms of the usefulness of the old "Question Box," a committee gave special attention to the editing of the questions and answers received this year. Only questions of a specific nature were included and answers which gave positive information. The questions related to preserving poles, details of overhead and track construction, lightning protection, power-apparatus maintenance, etc. The discussion turned on the advisability of continuing the "Box" in its improved form, rather than on the question's themselves. This was on account of the rush of closing hours and the members informally requested that the "Box" be kept up but advanced on the program of future conventions.

Meetings of Other Associations.

On account of limitations of space, it is not possible to present here a detailed report of the meetings of the Accountants', Transportation and Traffic and Claim Agents' Associations. The programs, however, are appended.

ACCOUNTANTS' ASSOCIATION.

President's Address.
Report of Executive Committee.
Report of Secretary-Treasurer.
Report of Committees on Interline Accounting, Car Miles and Car Hours, Engineering Accounting, Express and Freight Accounting, Life of Property, Standard Classification of Accounts, National Association of Railway Commissioners.
"Accounting System For a Small Railway," by Mr. E. D. Gault, Youngstown, Ohio.
"Prepayment Fare Accounting," by Mr. M. R. Boylan, Newark, N. J.
"Overhead Charges," by Dean M. E. Cooley, Ann Arbor, Mich.
"Statistics of Cost of Electric Operation on Steam Railways," by Mr. A. B. Bierck, New York City.

TRANSPORTATION AND TRAFFIC ASSOCIATION.

President's Address.
Report of Executive Committee.
Report of Secretary-Treasurer.
Reports of Committees on Subjects, Training of Employees, Passenger Traffic, Interurban Rules, Block Signals, City Rules, Express and Freight Traffic, Express and Freight Accounting, Fares and Transfers, Constructions of Schedules and Time Tables.
"Two-Car Train Operation," by Mr. C. J. Franklin, Portland, Ore.

CLAIM AGENTS' ASSOCIATION:

President's Address.
Report of Executive Committee.
Report of Secretary-Treasurer.
Reports of Special Committees.
"Selection of Trainmen and Method of Instruction to Secure Complete and Intelligent Accident Reports," by Mr. E. P. Walsh, St. Louis, Mo., and Mr. A. E. Beck, of Vancouver, B. C.
"The Prevention of Accidents: (1) What Can Be Done to Interest Employees in all Departments of This Work?; (2) The Best Means of Promoting Caution on the Part of Platform Men," by Mr. E. C. Carpenter, of Anderson, Ind., and Mr. F. S. Whitehead, of Washington, D. C.
"The Practical Value of the Index Bureau, With Some Statistics and Illustrations," by Mr. H. R. Goshorn, of Philadelphia, and Mr. C. G. Rice of Pittsburg.
"How Can the Public Be Educated in the Prevention of Accidents," by Mr. B. F. Boynton, of Portland, Oregon, and Mr. S. W. Baldwin, of New Haven, Conn.

The Outcome of the Federal Suit Against the Incandescent Electric Lamp Trust.

In Engineering News, March 16, 1911, we noted at length the suit brought by the U. S. Attorney-General, G. W. Wickersham, in the U. S. Circuit Court at Cleveland, O., against 35 manufacturing concerns on the charge of making unlawful contracts, combinations and conspiracies in restraint of interstate trade in incandescent lamps. The decree in the case was entered by Judge J. N. Killits at Toledo on Oct. 12. This decree is the result of a compromise between the defendants and the government, following the decisions of the Supreme Court in the Standard Oil and Tobacco Co. cases.

It will be recalled that the companies concerned manufactured some 97% of the incandescent electric lamps made in this country. The leading concerns involved were the General Electric and the National Electric Lamp Cos., the latter being a holding company through which the previously independent makers were controlled by the General Electric Co. The Westinghouse Electric & Mfg. Co. and the Westinghouse Lamp Cos. were also involved through agreements to maintain prices. The National Co. is dissolved and the component parts have been enjoined from continuing the practices which have served to restrain trade. The General Electric Co. is enjoined from doing any business in the manufacture and sale of electric lamps except under its own name. The outcome of the suit is summed up in a statement by the Attorney-General as follows:

First—The National Lamp Co. and all its subsidiary companies are ordered to be dissolved and the General Electric Co. is forbidden hereafter to conduct any business in the manufacture or sale of electric lamps except in its own name.

Second—The practice of fixing the resale price on any style of lamp, whether patented or unpatented, is hereafter forbidden, and when once a lamp has been manufactured by the owner of a patent or his licensee and sold to a wholesale or retail dealer, the price at which such dealer sells to another or to the public is open to free competition.

Third—The method by which competition in unpatented articles has been suppressed through the use of a patented article is declared to be unlawful, and is forbidden. But, in brief, it may be stated that the practice consisted in a system of contracts with dealers, jobbers and consumers by which they were compelled to agree to purchase from the defendants all their supply of carbon lamps on which the patent had expired as a condition to the right to purchase certain lamps known to the trade as tungsten, tantalum, and metallized filament lamps, which are still claimed to be patented. By means of aggregating discounts on lamps claimed to be patented with discounts on lamps not patented, another weapon was used to suppress competition in unpatented lamps. Both these practices had the effect of continuing a monopoly on an article long after the patent had expired by tying up its sale with a patented article which the trade required.

Fourth—The General Electric Co. and each and all of the defendants engaged in the manufacture of electric lamps are enjoined from entering into or carrying out certain contracts which it has been the practice to make in the past, by which the manufacturers of bulbs, tubing, and other parts necessary to a completed lamp, were bound not to sell the article manufactured by them to anybody except the defendants save upon unequal conditions. The result of this part of the decree is that independent manufacturers of electric lamps will hereafter be enabled to secure the parts necessary to such manufacture without the unfair and unnatural restraint which has heretofore existed.

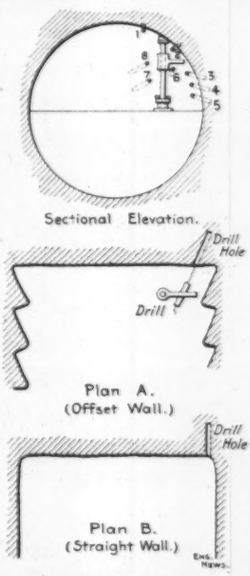
Fifth—All parties to the combination are enjoined from hereafter seeking to injure the business or secure the trade of rival manufacturers by offering and making terms or prices for incandescent lamps to the customers or such rival manufacturers more favorable than they make to their established trade, though nothing in the decree is to be taken in any respect as a restrain upon fair, free and open competition.

It may be proper to add that the investigation out of which this suit arose also disclosed eleven other patent pools of a similar nature by which the prices of various electrical devices and supplies were fixed and to which some of these defendants were parties. But since the institution of this suit all these pools have been voluntarily dissolved.

It may further be said that the investigation also disclosed a general trade and patent agreement between the General Electric Co. and the Westinghouse Electric & Manufacturing Co., the two largest electrical concerns in the country, covering substantially their whole business; but this agreement, since the institution of the Government's suit, has expired by limitation, and has not been, and it is believed will not be, renewed.

Drills With Long Column Arms for Work in Tunnels.*

In driving tunnel headings of oval or semi-circular cross section, ranging from 10 or 12 ft. up to 18 or 20 ft. in width on the floor, a customary method is to employ two columns, each carrying two drills. In order to complete the round and break the ground to the best advantage it is necessary either to move the columns or to set up a third column. A device for obviating this delay has been used recently with success in tunnels on the line of the new aqueduct for the water supply of New York City. It consists merely of a column arm of unusual length, 30 or 36 ins.



Elevation and Plans Showing Tunnel Driven with Drills Having Short and Long Arms on the Columns.

This arm is set near the bottom of the column, and gives the drill a much wider range in placing the holes than the arm of ordinary length. With this long arm, a tunnel wall or rib may be carried straight, instead of as a series of offsets, with the resulting roughness, which must be reduced by filling or trimming. In the accompanying cut, the elevation shows a column with a short arm. It must be set far enough from the rib of the tunnel wall to permit the arm to swing between the rib and the column when the arm is placed for drilling the holes at the top of the tunnel.

Hole No. 1 is drilled with the arm on the left side of the column. The arm is then swung to the position shown and holes Nos. 2, 6, 7 and 8 drilled. If this arm or a bottom arm of the same length is used for the lower rib holes, Nos. 3, 4 and 5 would be drilled as shown in plan (A) leaving an offset.

The use of a long arm on this column allows holes Nos. 3, 4 and 5 to be drilled straight, as shown in plan (B), and the difference in appearance of the rib when the two arms are used is shown by plans (A) and (B).

These arms are made of extra strong material to withstand the strain placed on them when the drill is working at the outer end.

Progress on the Elephant Butte Dam across the Rio Grande, New Mexico-Texas, is reported by the U. S. Reclamation Service. At the close of September the cofferdams above and below the dam site had been built out into the river to within 70 ft. of closure and were then being raised and widened. The excavation for the power-house foundation had been completed, and a portion of the machinery was being set up.

*From information furnished by the Sullivan Machinery Co., Chicago.

FIG. 1. GENERAL MAP OF BLACK RIVER VALLEY, WESTERN WISCONSIN.

Failure of the Dells and Hatfield Dams and the Devastation of Black River Falls, Wis., Oct. 6, 1911.*

By W. D. PENCE,† M. Am. Soc. C. E.

Early on the morning of Friday, Oct. 6, 1911, two dams owned by the La Crosse Water Power Co., located at and near Hatfield, Wis., on Black River, gave way due to the overtopping of earthwork dikes following a series of heavy rains. The flood sweeping down the narrow valley practically destroyed the entire business district of the Black River Falls, a prosperous little city of about 2,000 inhabitants located some twelve miles below the site of the main dam at Hatfield. Through the vigilance of the company's superintendent at the upper dam, who kept in close communication by telephone with the authorities at Black River Falls, it was possible to give due warning and to avoid all loss of life, although there were many narrow escapes.

The Dells Dam.

The failure of the upper dam, located at The Dells, some six miles above Hatfield, occurred about 6 a. m., Oct. 6, after a prolonged effort by a large force of men to maintain the crest of the dike above the water level, which had been steadily rising during a heavy downpour prevailing through the preceding day or two. The water had risen to a height of 7 ft. or more above the crest of the concrete spillway at the east end of the dam, when it was found necessary to abandon further effort at raising the dike; the large force of workmen was called off just after the initial breakover occurred. Within forty minutes the main embankment of the Dells dam for the full length of the core-wall, extending about 400 ft. from the west end of the main concrete dam into the west bank of the river, was entirely carried away and all the core-wall overturned except a short section of 30 ft. or so which held its connection with the main west headwall. The two views of the dam, Figs. 3 and 4 herewith, were taken some sixty hours after the break occurred. Fig. 4 is a view of the breach looking upstream. Fig. 3 is a view from the top of the dike near the west bank, sighting along the center line of dam; it shows the extreme westerly end of the core-wall in the foreground, further on broken sections of the overturned core or cut-off wall, and in the distance the fragment of the core-wall and a small body of earthwork immediately adjoining the main dam that were not carried away by the rush of water. The remainder of the overturned core wall is covered by water, probably lying flat on the scoured bed rock. The general layout of the Dells Dam, the dimensions of the main concrete structure, the spillway and other features are shown in the drawing Fig. 5.

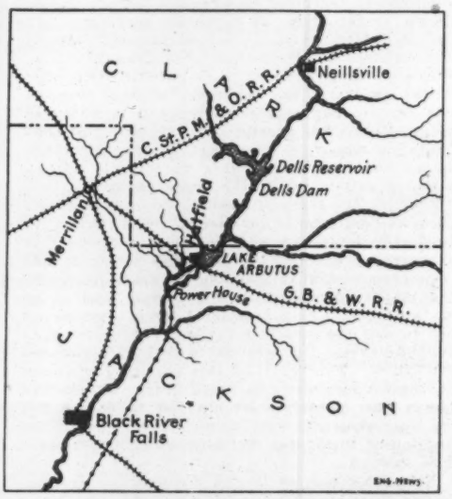


Fig. 2. Detail Map of Part of Black River Valley, Showing Relation of Dells and Hatfield Dams.

FIG. 3. DELLS DAM: VIEW ALONG DAM FROM WEST END.
(Broken core-wall of embankment overturned, in foreground. Short piece of embankment and core-wall in place at west end of spillway in distance. Intermediate part of core-wall probably lying flat on rock bottom.)

Some two weeks previous to the failure, considerable trouble was experienced due to the sudden rise in the level of the water in the Dells reservoir immediately following an unusually heavy precipitation, the heaviest, it appears, observed since the completion of the dam in the fall of 1909. In fact, the La Crosse Water Power Co. has suffered great embarrassment during the past two years from the marked deficiency in rainfall in this period. This condition is illustrated by the accompanying figures (Table I.) drawn from the record of rainfall observations made at Neillsville, a central point in the Black River valley, located some 8 mi. upstream from the Dells:

TABLE I. RAINFALL RECORD, NEILLSVILLE, WIS., 1910-1911.

Month.	Precipitation in inches. 1909	1910	1911
January	....	0.98	1.10
February	....	0.53	1.17
March	....	trace	1.77
April	....	4.10	1.60
May	....	1.89	7.56
June	....	0.51	6.50
July	....	2.76	3.81
August	....	5.26	3.90
September	....	2.57	7.97
October	....	1.35	
November	....	0.90	
December	....	0.65	
Total	32.83	21.47	35.38

(Normal Average about 32.5)

The rainfall record since the first of October,

*Examination made and report prepared by request of Engineering News. Photographic illustrations made by permission from views taken for the Railroad Commission of Wisconsin.

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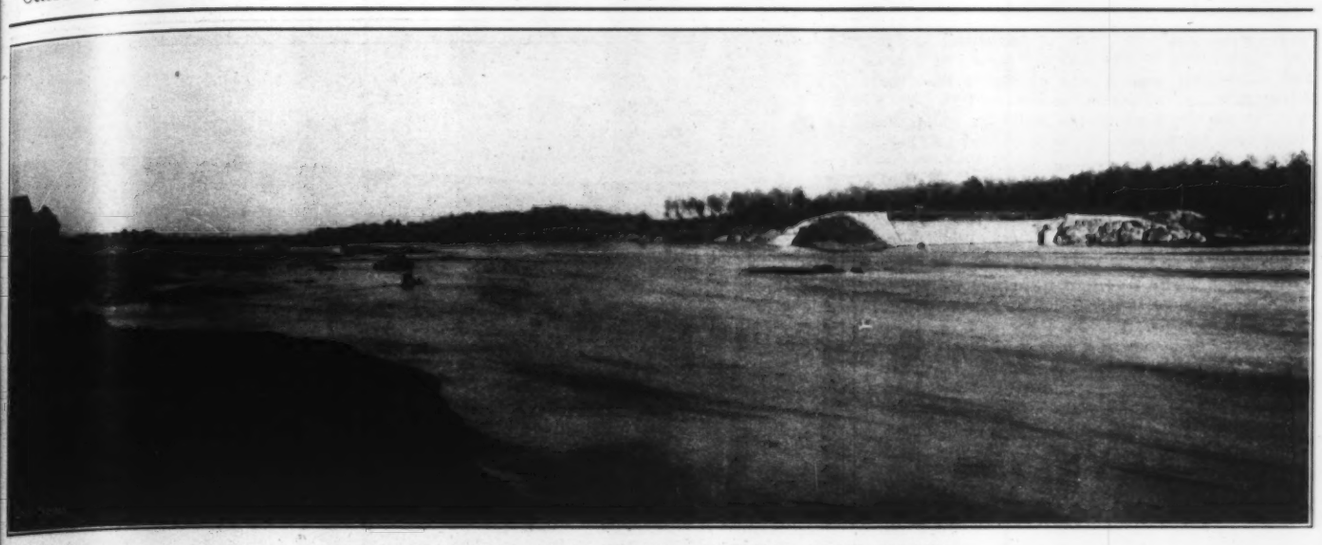

FIG. 4. DELLS DAM: VIEW LOOKING UPSTREAM, AFTER FAILURE.
(Dike west of spillway washed out when overtopped. See Fig. 5 for plans.)

1911, was as follows: Oct. 1, 0.53 in.; Oct. 3, 1.25 ins.; Oct. 5, 3.12 ins. The last record (3.12 ins.) covers the heavy downpour which, beginning at 1 p. m. Thursday, the day preceding the failure, prevailed throughout Thursday night and until 7 a. m. of Friday, Oct. 6.

On Sept. 28 the water level in the reservoir, as indicated on the gage board on the main concrete dam, rose to a height of 926.9, or within a foot or so of the top of the dike. This occurrence gave emphatic warning of the narrow margin of spillway under which the dam was operating. The flashboards, which at low-water stage had been extended to the full normal height of 3 ft., as indicated by Fig. 5, were all removed and the relief gates opened to their widest capacity. According to the statement of the company's superintendent, the water level had drawn down to 924.35 by the afternoon of Oct. 2. With the resumption of rainfall the water again began to rise at a rapid rate, and the situation grew so alarming that the force engaged in raising the dike by use of sand-bags and scrapers was considerably increased about the middle of the week. On Thursday about noon heavy rainfall commenced, and it continued throughout the night. The situation became so critical towards morning that about 4 a. m. the superintendent gave warning by telephone to the company employees at the lower dam and power station and to the authorities at Black River Falls that the dam was on the point of giving

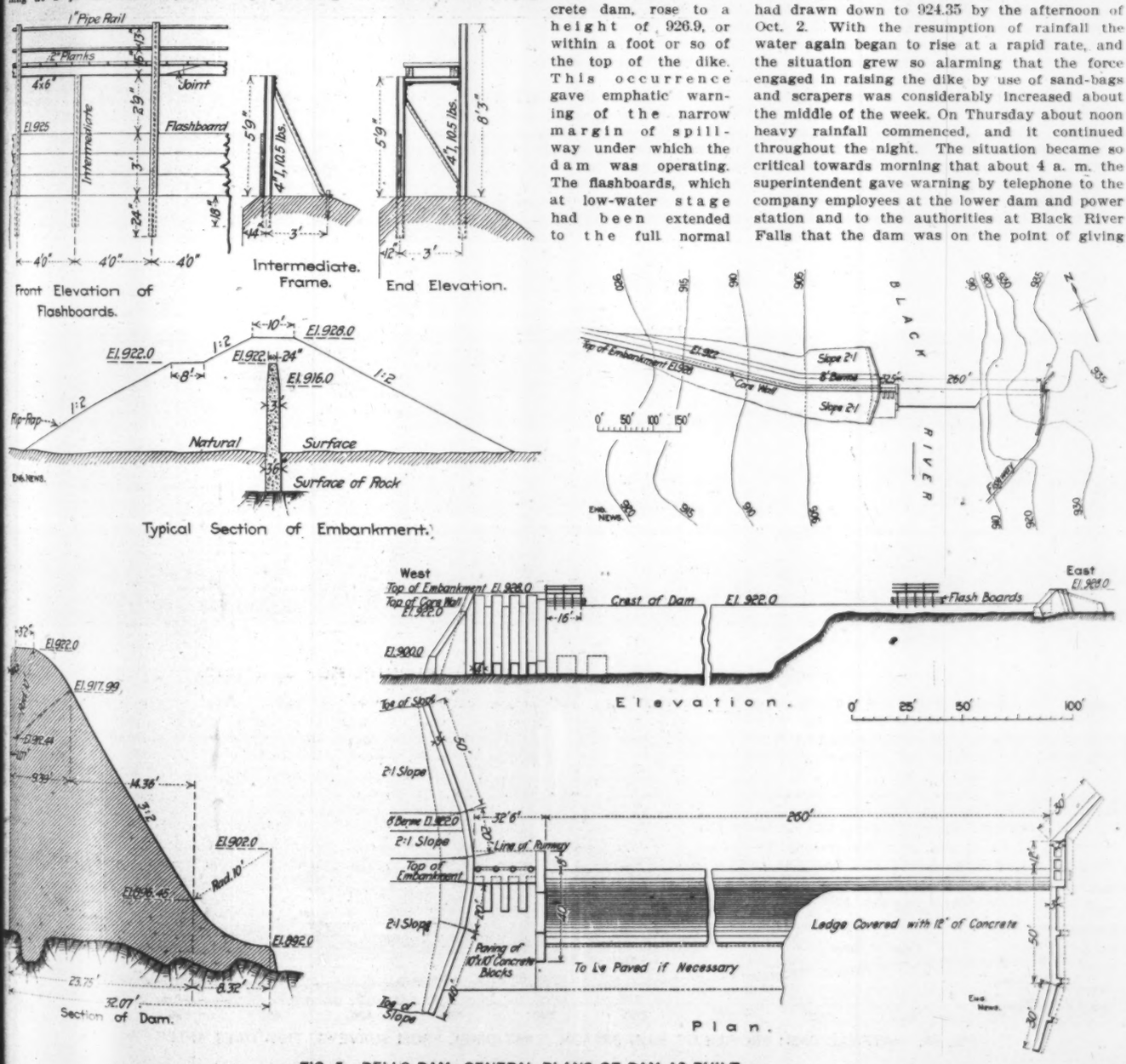

FIG. 5. DELLS DAM: GENERAL PLANS OF DAM AS BUILT.

way. Something like 2 ft. of additional height had been added to the dike by means of earth and sand-bags; and it was estimated that the water actually reached a height of 930 ft., or 8 ft. above the crest of the spillway, when the water first overtopped the embankment at about 6 a. m. Within less than an hour's time, as already indicated, the gap some 400 ft. long, substantially as shown in the photographic views Figs. 3 and 4, had opened up and the rush of water started towards the Hatfield dam six miles below.

The Hatfield Dam.

The location of the Dells and Hatfield reservoirs with relation to each other and to Black River Falls is shown in the map of Black River, Fig. 1, and more in detail in Fig. 2. As shown in the latter map, the east fork of Black River adds its waters to the main stream at a point between the two dams. Partly due to this fact, the height of water at Hatfield dam reached a somewhat threatening stage as early as 3 p. m. on Thursday, Oct. 5. Earlier in the week all the flashboards except the bottom one (10 ins.) had been removed. The heavy rains which fell through Thursday night brought the water to a still more critical stage before daybreak of Friday. When the rush of water from the breach in the Dells dam began to reach Hatfield about 8 a. m., the water at once rose over the wing-wall immediately west of the gatehouse, quickly stripping away the earthwork over the core-wall and breaking around the end, as shown in Fig. 8.

The wing-wall at the west end of the dam, it should be stated, is 2 ft. lower than that at the east end of the spillway, which accounts for the fact that the first overflow outside the limits of the spillway occurred on the west side, some time before the main breach in the long dike extending east from the spillway to the east bank of Black River, as described farther on.

The rush of water which found an outlet west of the gatehouse passed directly across the main track of the Green Bay & Western R. R., located a short distance southward from the dam and about parallel thereto, washing out the

FIG. 7. HATFIELD DAM: CONCRETE SPILLWAY.

(Photograph 60 hrs. after break. Note stumps and other debris behind dam crest and flashboards. Note damaged flashboard standards.)

CUTTING THE CANAL BANK.—The sheet of water at first flowed southward through the woods, filling up a gravel pit nearby, although a considerable portion of the water from this breakover flowed from the first directly into the headrace or main canal leading to the power plant 2½ mi. downstream. Anticipating the certain destruction of the power plant unless this gorging of the canal could be quickly relieved, and seeing that nothing further could be done to save the Hatfield dam, the small force of company men then at Hatfield (four men) set desperately to work digging a small trench through the sandy canal-bank at the bend about one-fourth mile downstream. The first breakover near the gatehouse probably occurred about 8.30 a. m., as above stated, and by 10 o'clock the trench had been cut. The force of the water at once opened up a large gap through the easterly bank of the flooded canal, as shown in Fig. 13. (This view, taken from the southerly side of the gap and looking up the bed of the canal towards the gatehouse, gives distinct evidence of the high-water scour line on the right and of the heavy erosion on the sandy banks to the left where the flood water found entry from point to point.) The relief came none too soon, for the men at the power plant were on the point

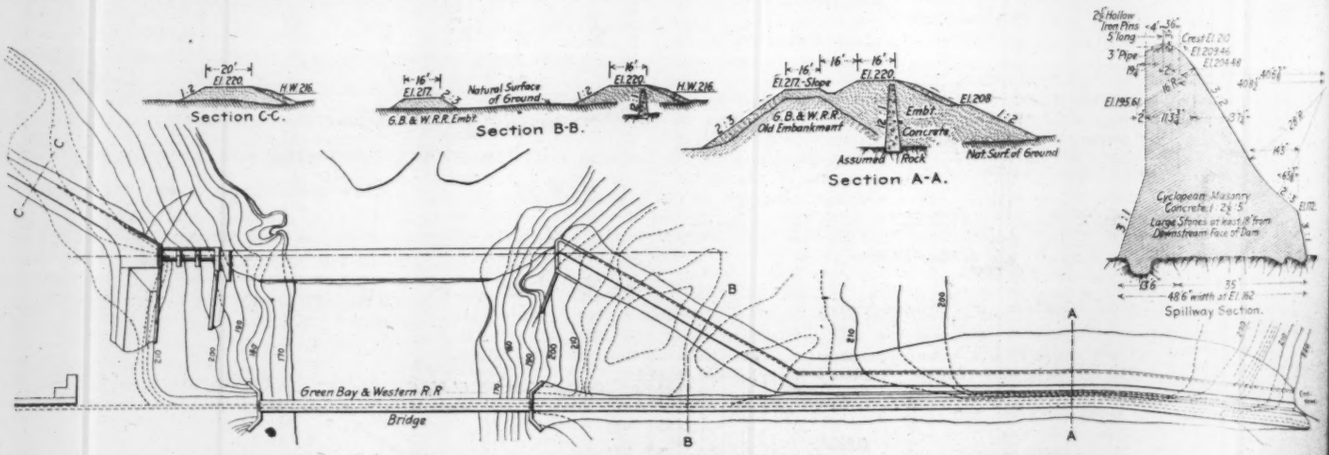

FIG. 6. HATFIELD DAM: GENERAL PLANS OF DAM, FROM COMPANY'S FILE BLUEPRINTS.

roadbed. In tracing up the time that this first rush of water occurred, it was learned that when freight train No. 9, westbound, arrived at Hatfield, 8.15 a. m., no water had yet passed over the track. It is stated that water was first seen coming over the wing-wall near the gatehouse about the time the train departed, 8.40 a. m., and that a washout west of the depot had started before the smoke of this train had entirely disappeared, say by 8.50.

of taking similar action to prevent the water from passing over the embankment at the power plant, where the level had actually risen to within 6 ins. of the top of the concrete head-masonry (Fig. 14) before it began to recede with the cutting of the canal bank as above described.

As already stated, the climax came at the lower dam with the arrival at Hatfield of the flood wave from the breach in the Dells Dam.

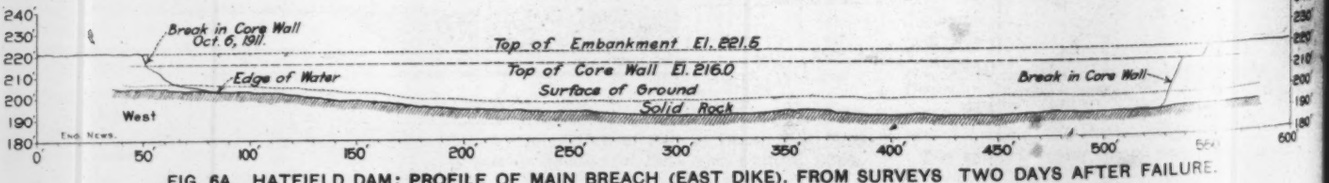

FIG. 6A. HATFIELD DAM: PROFILE OF MAIN BREACH (EAST DIKE). FROM SURVEYS TWO DAYS AFTER FAILURE.

FIG. 8. BREACH IN WEST DIKE; VIEW LOOKING DOWNSTREAM.
(Gatehouse at left.)

FIG. 9. BREACH IN EAST DIKE: CORE-WALL AT WEST END OF BREACH.

FIG. 10. BREACH IN EAST DIKE: OVERTURNED CORE-WALL; LOOKING EAST.

FIG. 11. BREACH IN EAST DIKE: GENERAL VIEW, LOOKING EAST AND DOWNSTREAM.
(This was the main breach, though occurring after the failure of the west dike, Fig. 8.)

FIG. 12. WATER FLOW IN NEW CHANNEL ABOUT 1,000 FT. BELOW EAST DIKE, NEAR POINT WHERE WATER RETURNED TO OLD CHANNEL.
(Photographed 2½ days after failure of dam.)

FIGS. 8 TO 12.
VIEWS AT THE HATFIELD DAM AFTER FAILURE.

FIG. 13, HATFIELD POWER CANAL:—BANK TRENCHED ABOUT ¼-MILE BELOW DAM TO SAVE POWERHOUSE; CUT IN BANK GREATLY ERODED BY OUTFLOW.
(Looking upstream.)

FIG. 14. CONCRETE-LINED CANAL AT ENTRANCE TO POWERHOUSE.
(Looking upstream. Powerhouse to right of foreground.)

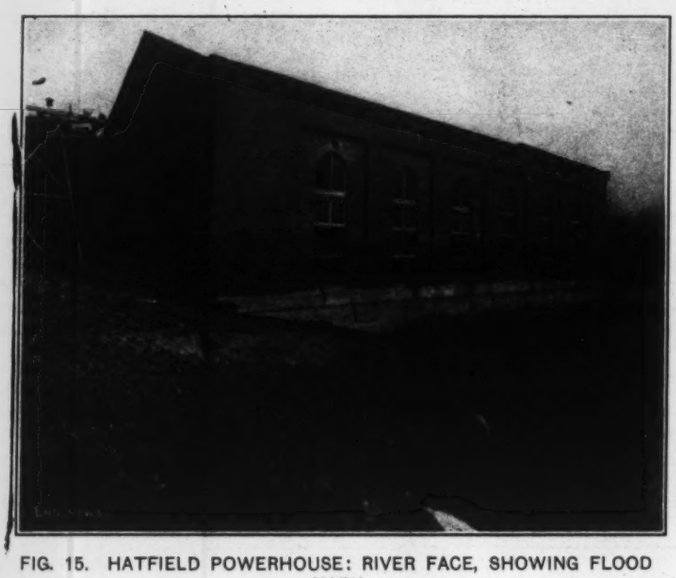

FIG. 15. HATFIELD POWERHOUSE: RIVER FACE, SHOWING FLOOD MARK.
(Photograph 3 days after flood, showing water stage at that time.)

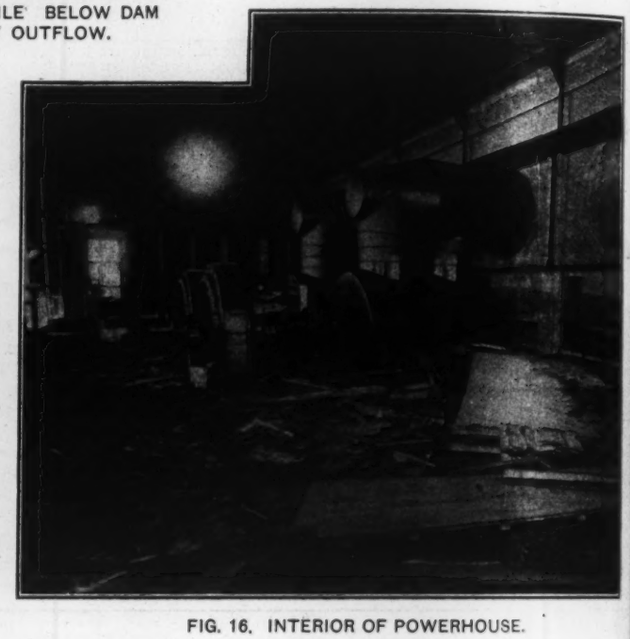

FIG. 16. INTERIOR OF POWERHOUSE.

With this rush naturally came a considerable quantity of drift in the form of old stumps and "deadheads" or water-soaked logs to be found in all old milling streams. The statement of the section foreman of the Green Bay & Western R. R. that a considerable accumulation of such drift, extending out some distance above the spillway, could be seen from where he stood near the depot as the water broke through, is fully confirmed by the conditions noted in Fig. 7, a photographic view of the spillway taken some sixty hours after the break occurred. Aside from the large accumulation of logs and stumps, it is noted that at least a portion of the lower tier of flashboards were still in place when the failure occurred, and that the steel standards for the flashboards with the supported footwalk were disabled by the force of the spillway flow. It will be noted at the extreme right of this view (Fig. 7) that the earth had not been eroded over the east wing abutment, it being remembered in this connection that the top of this wall is some 2 ft. higher than the top of the wing-wall west of the gatehouse (seen in the distance). Fine drift, such as chips of wood, strewn along the upstream side of this earthwork a few feet to the right of the limit of this view, showed that the water at that point rose to an extreme height 1 ft. above the top of the end wall, or a total of 11 ft. above the crest of the concrete spillway.

Levels taken on Oct. 8 at the dam by the company's engineer, who made the profile Fig. 6A, gave datum elevations as follows: East end of spillway, top of wing-wall, 220.15; top of embankment at about middle point between wing-

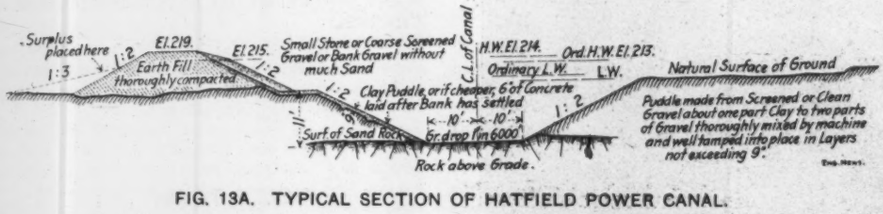
Surplus placed here
1:3
1:2
El. 219.
Earth Fill thoroughly compacted
El. 215.
1:2
Small Stone or Coarse Screened Gravel or Bank Gravel without much Sand
C.L. of Canal
H.W. El. 214.
Ord. H.W. El. 213.
Ordinary L.W.
L.W.
Natural Surface of Ground
1:2
Clay Puddle, or if cheaper, 6" of Concrete laid after Bank has Settled
Puddle made from Screened or Clean Gravel about one part Clay to two parts of Gravel thoroughly mixed by machine and well tamped into place in Layers not exceeding 9".
Surf of Sand Rock
6" drop in 6000
Rock above Grade.
Eng. News.

FIG. 13A. TYPICAL SECTION OF HATFIELD POWER CANAL.

wall and end of main break in east dike, 221.32; water level shown by fine drift at east end of main dam, 221.15; top of core-wall at break (about Sta. 9 + 10 of the profile Fig. 6A), 216.0. Tape-line measurement showed a 10-ft. drop from top of (east) wing-wall to spillway, giving a datum height of 210.15 for the spillway crest. The wing-wall west of the gatehouse, as already indicated, was built only 8 ft. higher than the spillway crest, although the plans, Fig. 6, call for an elevation of 220. It would therefore appear that at the time the flood level attained the elevation shown by the extreme high-water marks already mentioned, a foot or so higher than the concrete abutment at the east end of the spillway, Fig. 7, there was probably a depth of as much as 3 ft. above the concrete wing and core-walls just west of the gatehouse, Fig. 8.

BREACHING OF THE EAST DIKE.—Up this time it appears that no water had broke over the long dike extending to the main easterly bank of Black River bottoms, for it was found in tracing the limit of fine debris along the crest of the surviving portions of the earthwork east of the spillway, shown in Fig. 11, that there was a drop of several inches in the flood gradient westward to the spillway from a point near the abrupt angle in the embankment shown in the view (Fig. 11) and in the plan Fig. 6.

At this point attention should be called to the fact that the elevations quoted above, taken Oct. 8, indicate that the earth embankment for some reason was built to a height (El. 221.15) more than a foot above that indicated in the drawings (El. 220.0). No figures are at hand to indicate the precise elevation to which the top of this embankment was constructed in the easterly portion, the portion carried out. Even if the dike were built precisely to the same elevation throughout its length, it is quite certain that there would be inequalities in the shrinkage and settlement of the earthwork, particularly in the higher portion carried away, where there was said to be a swale or a somewhat marshy stretch. This marshy place, it may be noted, was crossed by a timber trestle in the original

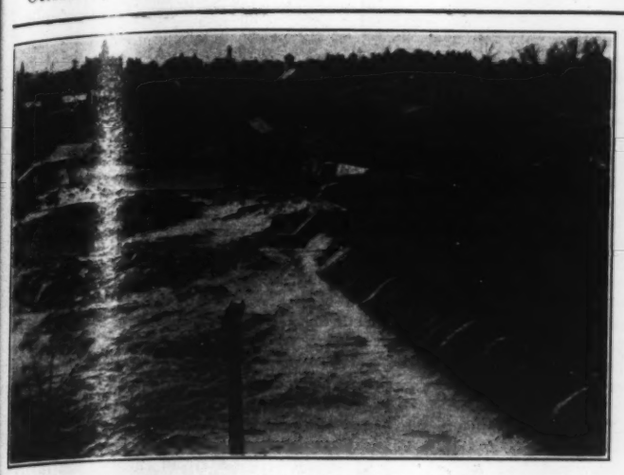

FIG. 17. BEFORE THE FLOOD: LOOKING WESTWARD AT MUNICIPAL DAM, SHOWING REGION WHERE EROSION OF BANK STARTED.

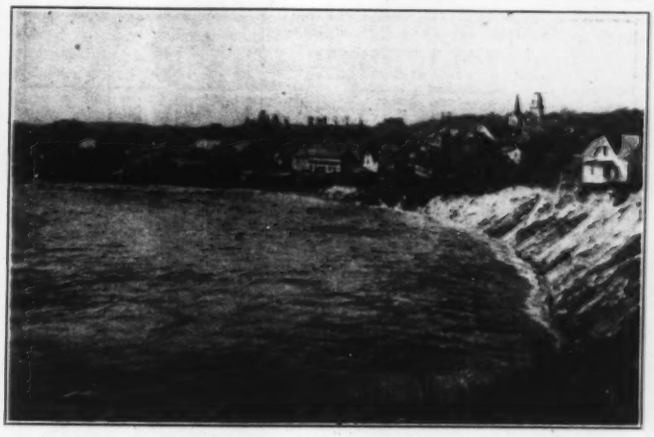

FIG. 18. AFTER THE FLOOD: ERODED PART OF HILLSIDE.
(The business section stood in the foreground, where the new channel now runs.)

FIG. 19. LOOKING UPSTREAM TOWARD C. ST. P. M. & O. RY. BRIDGE.
(Old channel at right. New channel behind municipal dam and rock outcrops at left.)

FIG. 20. PANORAMIC VIEW FROM TOP OF BLUFF AT WEST BORDER OF ERODED AREA.
(View from point marked A in Fig. 19, at height of 40 to 50 ft. above water level.)

FIGS. 17 TO 20. BLACK RIVER FALLS, WHOSE BUSINESS SECTION WAS DESTROYED BY UNDERMINING AND CAVING.

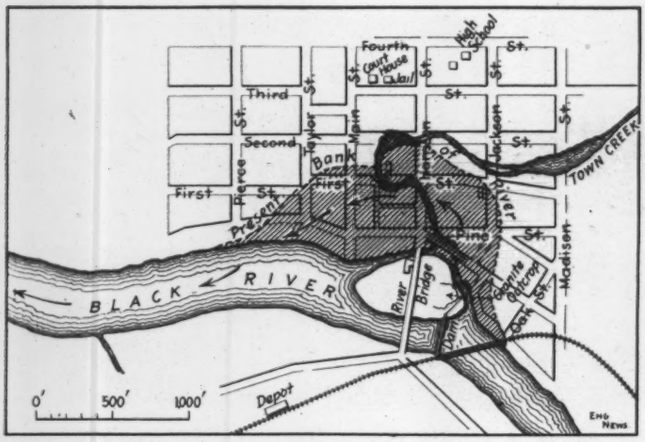

FIG. 21. SKETCH MAP OF ERODED AREA OF BLACK RIVER FALLS.

construction of the Green Bay & Western R. R. in 1872, the trestle being replaced a few years later by a solid embankment.

It is stated that the initial flow of the flood waters over the east dike occurred not far from the east end, but no eyewitness to this fact was found. Fig. 11 clearly indicates the erosion due to the action of waves produced in the extended sheet of water to the northward by the stiff breeze prevailing at the time. These waves would probably have their maximum effect at the extreme end of the expanse of water in the direction that the wind was blowing, and it is not unlikely that the water broke over simultaneously at several points near the easterly end of the embankment. This breakover occurred about 9 a. m., and the resulting washout of course included the roadbed and track of the Green Bay & Western R. R., the position of which with reference to the dam at this place is best indicated by Section A-A in the drawing Fig. 6.

The overtopping water appears to have carried away the earth at once down as far as the top of the core-wall. The elevation of the top of this wall, according to the levels taken by the company's engineer on the morning of Oct. 8, was 216.0 as given in the profile Fig. 6A, instead of 218.0 as indicated in Sections A-A and B-B of Fig. 6, the latter drawing being traced from the original blue prints on file in the company's office. With the erosion of the earth from the downstream side of the core-wall, this wall must quickly have been overturned. The torrent of water thus released, cutting at once to bedrock, passed swiftly down the newly formed channel, and back into the old bed of the river at a point 1,000 ft. or more downstream from the concrete spillway. Some idea of the tremendous force exerted by this flood can be gained from the photographic view Fig. 12, taken just upstream from the above-mentioned junction with the old channel of Black River, some sixty hours after the break occurred.

Somewhat distinct evidence is found on the ground that the water level, which must have undergone a rapid drop immediately after the main breach occurred, held rather steadily at an elevation approximately identical with that of the top of the core-wall. The two ends of the broken core-wall as shown in Fig. 11 (looking downstream). Fig. 9 shows at close range the upstream side of the broken end of the core-wall as same is indicated near Station 9 of the profile (Fig. 6A). Fig. 10 shows the contiguous portions of fractured and overturned core-wall. Observations at the point indicated in Fig. 10, on the following day (Oct. 9), at a still lower stage of the water, showed that the ripple in the foreground was caused by the water pouring over what appears to have been a construction level, probably a footing plane, in the concrete core-wall.

The Powerhouse.

The company employees at the power plant had learned from the superintendent in charge at the Dells, as early as 3.45 a. m., Friday, that the upper dam was on the point of going out. At 5.05 a. m., when positive word came from above that the water was on the point of breaking over, the power plant was promptly shut down and was not again operated. The families of the employees were at once removed from the company residences, located in the probable path of the flood, to a place of safety. During a period of several hours those at the plant were entirely isolated, and no evidence was had as to events upstream until a sudden rise of water was noted, first in the canal (shortly after 8.30 a. m.), and then in the main channel of Black River alongside the power plant building (about 9.15 o'clock). Fig. 14 shows the concrete headworks at the south end of the canal, where, as already explained, it was apprehended that the flood waters would overflow the banks and destroy the power plant proper. The powerhouse is just to the right of the foreground of this picture. At 9 a. m., Oct. 6, the water level in Black River was at approximately the height shown in Fig. 15, taken after the flood had run out, some three days after the break. This view also shows by the water-soaked space on the brickwork the height covered by the flood water at the maximum stage. It is stated by the chief engineer at the plant that the first rush of water down the main channel reached the plant at 9.15 a. m., and the maximum height shown in Fig. 15 was attained by 10.30 a. m.

The effect of the flood on the interior of the building is shown in Fig. 16, in which it will be noted by the drift lodged on top of the generators that the water reached a height of some 12 ft. above the floor. Oddly enough, the high-water mark is plainly indicated by a film of oil left on the steel tubes above the turbine casings, a tank of oil having been overturned near the upstream end of the room as the water first rushed through the windows. The damage, both to the building and machinery, is merely nominal. It is stated that with the exercise of due care the damage need not be more than $100 to the main generating machinery, which at present consists of two 2,400-KW. three-phase 60-cycle 2,300-volt generators of the horizontal-shaft revolving-field type, direct-connected to the turbines and operating at 300 r.p.m. As will be seen in Fig. 16, only two of the four generating units planned for have been installed.

Destruction at Black River Falls.

At Black River Falls, located some twelve miles downstream from the Hatfield dam, warning had been given of the impending failure of the Dells dam before daybreak on Oct. 6. The river had been in flood for some days, due to the heavy rains. As early as 10 a. m. the river began to rise quite rapidly, and in the course of the next few hours the peak of the flood, due to the breaks above described, reached Black River Falls with full force. The stream passes in a comparatively restricted channel underneath the bridge of the Chicago, St. Paul, Minneapolis & Omaha Ry., as indicated in Fig. 18. This view was taken looking upstream, with the old channel of the stream shown on the right. The dam shown in the foreground appears to have acted substantially as a wing dam, deflecting the swift and rising flood-current sharply to the right against the unprotected toe of the river bank.

The outcroppings of granite on either side had led to the belief that the high sandy riverbanks, sloping abruptly down into the river bottoms and occupied by the business district of the city, were probably underlain by this same rock. This idea, however, was soon found to be erroneous, for with the approaching peak stage of the flood from the break in the Hatfield dam, towards noon, the bank had yielded to the scouring action to such an extent as to forecast the destruction of the entire business district. In fact, the inroad upon the yielding slopes progressed so rapidly that the river forced for itself an entirely new channel within the next few hours. The amazing consequences of this swift scouring action of the deflected stream are clearly shown by the panoramic view Fig. 20, taken from point A in Fig. 19, looking downstream from a point 40 or 50 ft. above the river level. The point of initial attack of this scour is clearly shown in Fig. 17, a photographic view taken some time ago looking westward in the general direction of the municipal dam.

FIG. 22. A HIGHWAY BRIDGE CARRIED OUT BY THE BLACK RIVER FLOOD.

Referring further to **Fig. 19**, it should be noted that the flood at its peak stage reached the lower chord of the main deck spans of the railway bridge. The breach near the east end of the concrete dam was made by dynamite on Oct. 9, in an attempt to restore the river to its old channel. In Fig. 19, the new channel sweeping to the left is hidden from view by the dam and outcropping rock adjacent thereto.

Hydrology of Black River.

Before closing this report, some reference should be made to the characteristics of Black River itself. This river is known by hydraulic experts as a "flashy" stream. The following statement touching upon its characteristics is quoted from Smith's "Water Powers in Wisconsin," pp. 169-171:

GEOLOGY.—All that portion of the river from Black River Falls northward is in the hard pre-Cambrian rock. For a large share of this stretch the river has worn deeply into the rock and banks that rise abruptly 40 to 60 ft., often with nearly vertical walls. In places, however, the rock is covered by the glacial deposits. In the 55 miles between Black River Falls and its mouth, the river flows in the Potsdam sandstone region, but even here the average slope is 2.2 ft. per mile. The valleys, however, are wide and the banks usually low, making the development of water power expensive, and more difficult of maintenance.

RAINFALL.—A study of rainfall records shows that the average annual rainfall on the drainage area between the years of 1893 was 31.84 ins. This was distributed among the three important periods as follows: Storage period 12.15 ins., growing period 9.57 ins., and replenishing period 9.41 ins.

TOPOGRAPHY AND DRAINAGE.—Black River, hemmed in by the Chippewa on the west and the Wisconsin on the east, is restricted to a long and narrow watershed of about 2,270 sq. mi., with an average width of only 20 mi. At one point the branches of Chippewa River extend to within a quarter of a mile of Black River. Like the Chippewa, about a third of the Black River drainage area is in [illegible]tively level sandstone region, so that the maximum watershed available for water powers, namely, at Black River Falls, is only 1,570 sq. mi. The watershed narrows rapidly as the river is ascended, and at Neillsville, 22 miles in an air line from Black River Falls, the drainage area is reduced to only 729 sq. mi. Were it not for the small watershed, the steep gradient of the river and its high, rocky banks would insure large water powers.

Black River rises at an elevation of about 1,400 ft. above sea level, and after a sinuous course of over 140 miles joins Mississippi River at La Crosse.

A gaging station was established at Neillsville in 1905 by the U. S. Geological Survey, and observations were taken continuously up to 1908, when the station was unfortunately abandoned, owing to lack of funds. Steps are now being taken to re-establish this observing station. On p. 175, Smith gives a table of the estimated monthly discharges of Black River at Neillsville for the years 1905 and 1906, in which the maximum discharge of 22,000 sec.-ft. is recorded in June, 1905. The minimum for the same month was 205 sec.-ft., and for the year (in October, 1905), 20 sec.-ft.

The area of the Black River watershed above the Dells dam is estimated at about 950 sq. mi., and above the Hatfield dam about 1,350 sq. mi. The normal storage capacity of the Dells reservoir is 10,580 acre-feet, and of the Hatfield reservoir 9,923 acre-feet. These storage figures are based, presumably, upon the usual flashboard heights of 3 ft. and 5 ft., respectively, at the upper and lower dams.

Workmanship and Design of the Breached Dams.

In the course of the descriptive details of the foregoing report on the failure of the two dams, no reference has been made to the quality of the workmanship or design. In the somewhat rapid examination necessarily made in the progress of the field inspections leading up to this report, no evidence was found of faulty construction work. The fracture and overturning of the concrete core-walls was, of course, to be expected under the circumstances described; but the quality of the concrete itself was uniformly excellent.

Referring to the matter of spillway, which is obviously the vital question in determining the responsibility for the failure of the two dams, there is lacking definite information as to the basis upon which the designers made their calculations. There is even difficulty in ascertaining who was responsible for this important detail of the design; for there appears to have been lacking a central personality, possessing conspicuous professional ability in this field, and having both the authority and the disposition to control the execution of this important project from start to finish. The extreme hazard, either in the lack of such responsible head, or in a faulty division of responsibility, has been so fully exemplified in recent failures of engineering works of large magnitude as to need no further comment in this connection.

Judging from results, it does not appear that adequate consideration was given by the designers to the characteristics of this stream, in providing spillway relief to the flood waters at maximum stage; nor to the certain reduction in discharge over the crest of the concrete spillway, due to a large accumulation of stumps and logs held back by flashboard guides, such as were used on these dams.

In spite of the fact that the water had reached a threatening stage at the Hatfield dam, it is generally believed that its failure was due to that of the Dells dam. *If, in the past, it might have been regarded as a debatable question whether a dam should be designed to meet this contingency, these recent experiences on Black River certainly tend strongly to force future practice to another and higher plane.*

The writer desires to acknowledge his obligations to the Railroad Commission of Wisconsin for kind permission to use for the purposes of this report the photographic views taken under special authorization; and to Mr. R. M. Feustel, Assistant Engineer, and other members of the engineering staff who rendered valuable assistance.

A Road Roller Crushed a Man at Orange, N. J., Oct. 13. The victim was in charge of the roller, and according to the press reports, had tried several times to drive it up the short slope leading to the Delaware, Lackawanna & Western R. R. tracks on Joyce St. Finally he succeeded, but lost control of the machine, which ran at high speed down the slope beyond the track crossing and, leaving the road, collided with the porch of a house. The jolt threw the driver to the ground and the roller came back upon him due to the grade of the lawn. Reports state that he was smashed flat with the exception of one foot and arm.

A Butting Collision between a freight and a passenger train on the Missouri Pacific Ry., at Fort Crook, ten miles south of Omaha, Neb., Oct. 15, killed seven persons, of whom six were passengers, and injured 22 others. The accident is ascribed to disregard of meeting orders on the part of the freight train's crew. The accident took place at a sharp curve, according to press reports, making it seem probable that the enginemen each supposed, until too late to prevent a collision, the other's train was on the tracks of the Chicago, Burlington & Quincy R. R., which parallels the Missouri Pacific at this point. This division of the Missouri Pacific is a single-track line.

Another Reinforced-Concrete Building Collapse because of premature removal of forms occurred at Ilion, N. Y., Oct. 12. The building in question is a new office building for the Remington Typewriter Co. The roof of the building was completed about Oct. 3 and since that time the weather has been cold and damp. Workmen began removing forms on the morning of Oct. 13, as they had been ten days in place, but worked with caution as there were evidences that the concrete had been slow in setting. Shortly the evidences of impending failure became such that the workmen sought safety. Part of the roof then fell, carrying down with it the floor below.

A Street Viaduct at Akron, Ohio, fell on the night of Oct. 10, through having its foundations undermined by excavating work. The press dispatches first sent out after the accident stated that a reinforced concrete viaduct costing $250,000 had collapsed. Investigation showed that the structure was of steel instead of concrete and that the failure occurred from a cause which would have wrecked a structure of any material.

The facts concerning the accident as reported to us by Mr. L. P. Winterhalter, Assoc. M. Am. Soc. C. E., of Akron, are briefly as follows: The structure was a steel bridge about 200 ft. long, forming an approach to the Mill St. viaduct in Akron. It was supported by steel columns resting on concrete piers. Excavating was going on underneath this viaduct by the construction forces of the Cleveland, Akron & Cincinnati R. R., to obtain head room for a siding leading to a freight house. The steam shovel gang had been cautioned not to excavate too deep or too near to the concrete piers supporting the viaduct overhead. Earth from the excavations had been piled around a pier, however, which was about 6 ft. square and 7 ft. high with its footing about 2 ft. below the original surface. The accident occurred at 11.40 p. m., when the night force at work could not see very clearly what they were doing. They carried the excavation some 2 ft. below the base of the concrete pier. The sand beneath it flowed out, the pier overturned and the steel column carrying the viaduct overhead slid off the pier as it went over. The opposite column and the girders it carried remained in place. The structure gave enough warning of its fall to enable the working gang to escape and even move the steam shovel back to a safe place. A sidewalk of reinforced concrete on the opposite side of the viaduct was the only part of the structure of that material and probably gave the foundation for the press dispatch above referred to.

Collapse of a Building under construction in Boston, Oct. 10, killed three men. The following are extracts from the report on the disaster made by Building Commissioner Arthur G. Everett:

The collapse was occasioned by the sinking of an iron column supporting the corner of the building and carrying on steel beams about 20 ft. of wall on each of the two streets.

"Upon uncovering the columns and the foundations under it, it was found that the column had sunk about 4 ft. into the masonry pier built to support it. The column is of cast iron 7 ins. in diameter with a shell 1 in. thick standing on a cast-iron plate 16 ins. square and 1 in. thick. The column was filled with concrete and faced off square on the bottom, and was found intact and in good condition. The iron plate upon which it stood was broken in five pieces, the central piece being carried by the column down through the foundations below.

Beneath the iron plate was a brick pier 2 ft. 4 ins. square and about 18 ins. high, and beneath the brick pier a stone foundation about 3 ft. deep. The stone foundation was built with a few large stones on the outer side toward the two streets and with small stones at the back against the old cellar walls and with many hollow spaces. The brickwork above the stone was laid up with little, if any, bond, and both stone and brickwork were laid in very poor mortar. The brickwork when uncovered showed moisture and it seems apparent that the rains of the days preceding the collapse softened and in a measure washed out the mortar in both the brickwork and the stone under it.

The collapse was occasioned by the iron column being forced down through the iron plate, the brickwork and the stone foundation under the brick pier to a large stone near the bottom of the stone work.

The weight carried on the column was something over 40 tons. The column, brick pier and stone foundation, properly built in good mortar, would carry at least one-half more weight than was imposed on them, and ignorance or carelessness must account for the bad workmanship.

The larger stones being on the face of the work and the brick work being well finished with cement on the outside, the appearance, of the work when finished did not suggest to the inspector, Mr. Oliver, the miserable construction in the interior of the pier. And as the other masonry in the building was well done, there seemed no reason for suspecting bad work at this point. The pier was built between visits by the inspector, and was not seen by him until finished with the columns set upon it.

It is impossible for an inspector to see all the work in every building in the district when, as in the present instance there are about 75 buildings and alterations in process subject to his inspection, and I find no reason for placing responsibility for this deplorable accident on Mr. Oliver.

To guard against similar occurrences in the future it may be necessary to compel the employment by the owner of a qualified and licensed clerk of the works who shall be responsible for the construction of the foundations, walls, floors and all structural parts of a building.

A Permanent Water-Supply for Mount Vernon, N. Y., under municipal ownership, has been recommended by Mr. George W. Fuller, M. Am. Soc. C. E., of 170 Broadway, New York City. The city is now supplied with surface water from various sources, which proved so inadequate during the dry season of 1910 that relief was sought and obtained from New York City. The present works are owned by the New York Inter Urban Water Co., the successor of various earlier companies. The contract with the company expired in 1908. Mr. Fuller advises the purchase of the works of the company named, either by agreement or condemnation, and the development of an additional supply which would increase their daily capacity from 2,500,000 to 5,000,000 gals., and ultimately to at least 7,500,000 gals. The additional supply, Mr. Fuller concludes, could best be secured by storage on the Mamaroneck River, accompanied by filtration. The value of the physical property

of the water company is placed at $1,619,000, but this includes $403,500 for distribution works outside of Mount Vernon, which might perhaps be sold. To the physical valuation should be added perhaps one year's interest to correspond to the average interest charges during an allowance of two years for construction, and also a moderate sum for going value. The estimated cost of a 5,000,000 gal. additional supply from the Mamaroneck River is about $900,000 to which $100,000 should be added for reinforcing the pipe system in Mount Vernon. It is interesting to note, that although Mt. Vernon, like other Westchester Co. municipalities, has statutory authority to take water from the Catskill supply now being developed for New York City, the price has been fixed at the rate charged private metered consumers by New York City, which now is 13⅓ cts. per 1,000 gals. On this basis, with allowance for the cost of connections, a 5,000,000-gal. supply from the Catskill Aqueduct, Mr. Fuller estimates, would cost Mt. Vernon $170 per 1,000,000 gals., against $85 from the Mamaroneck River, while for 7,500,000 gals. a day the respective unit costs would be $161 and $66. Mr. Fuller's report is addressed to the Board of Water Supply of Mt. Vernon, a body created by a legislative act approved on May 10, 1911. Mr. John W. Stevens is president, Dr. W. H. Purdy is secretary and Mr. Benj. J. Cullen is treasurer of the board, which consists of these three men only.

The Panama Canal will be ready for the passage of vessels by July 1, 1913, according to the Annual Report of Col. George W. Goethals, Chairman of the Isthmian Canal Commission, made public on Oct. 17. Prompt legislation to fix tolls for the use of the canal is recommended, also legislation for the establishment of a permanent operating force. He urges that the Government itself should provide coaling facilities, and furnish fuel and other supplies to vessels using the canal, and should also build a drydock and repair station.

Personals.

Mr. A. M. Merryweather has been appointed Manager of the newly-opened office of the Brown Hoisting Machinery Co., of Cleveland, Ohio, in the Commercial National Bank Bldg., Chicago, Ill.

Mr. Alfred H. Brooks, M. Am. Inst. M. E., for the past ten years Geologist in charge of Alaskan surveys of the U. S. Geological Survey, has been appointed Chief Geologist of the U. S. Geological Survey.

Mr. George Y. Skinner, for several years associated with Mr. C. U. Powell, Civil Engineer, of Flushing, N. Y., has taken a position with Samuel Parsons & Co., Landscape Architects, 1133 Broadway, New York City.

Mr. S. Z. de Ferranti, President of the Institution of Electrical Engineers of Great Britain, is visiting this country. He is accompanied by several prominent English engineers and will spend some time inspecting the recent electrical developments in New York, Chicago and other American cities.

Mr. Walter S. Painter, for several years Chief Architect of the Canadian Pacific Ry., has resigned to enter a partnership with Mr. F. S. Swales, a London architect, with offices in Vancouver, B. C., and Montreal, Que. Mr. Painter will be retained by the Canadian Pacific Ry. in a consulting capacity on several important projects in the West.

Mr. Gano Dunn, President of the American Institute of Electrical Engineers, formerly First Vice-President and Chief Engineer of the Crocker-Wheeler Co., of Ampere, N. J., has been elected a director and Vice-President of J. G. White & Co., Inc., New York City. Mr. Dunn has recently returned to this country from Europe, where he attended the International Electrical Congress at Turin and the meeting of the International Electro-Technical Commission as the official American representative. Mr. Dunn will take charge of the engineering department of J. G. White & Co.

Messrs. Henry A. Young, Assoc. M. Am. Soc. C. E., formerly of the Jobson-Hooker Co., New York City, and Howard E. Hyde, Assoc. M. Am. Soc. C. E., formerly Engineer in charge of designs of the Havana, Cuba, sewerage and drainage systems, have formed a partnership for the practice of civil and sanitary engineering with offices in the Produce Exchange Bldg., New York City.

Mr. J. G. Sullivan, M. Am. Soc. C. E., formerly Assistant Chief Engineer of the Canadian Pacific Ry., has been promoted to Chief Engineer of the Western Lines of the same railway. The position of Assistant Chief Engineer is abolished.

The Missouri, Kansas & Texas Ry. has announced the following changes and promotions: Mr. J. W. Walton, formerly General Superintendent, to be Assistant General Manager of the lines in Texas, with headquarters at Dallas, Tex., succeeding Mr. C. M. Bryant, resigned; Mr. W. E. Williams, formerly Superintendent at McAlester, Okla., to be General Superintendent at St. Louis, Mo., vice Mr. Walton; Mr. K. A. Easley, formerly Assistant Superintendent at Parsons, Kan., to be Superintendent at McAlester, Okla., vice Mr. Williams; Mr. J. H. Hickey, formerly Assistant Superintendent at McAlester to Parsons, Kan., vice Mr. Easley, and Mr. R. R. Farmer is appointed Assistant Superintendent at McAlester, vice Mr. Hickey.

Obituary.

Peter Wind, a well-known building contractor of Omaha, Neb., and Council Bluffs, Iowa, died at his home in Council Bluffs on Oct. 7.

Sir William John Crossley, M. I. Mech. E., founder of the engineering firm of Crossley Bros., Ltd., Manchester, England, died on Oct. 12 in London. He was born in Dunmurry, Ireland, in 1844. He served an apprenticeship in engineering with Sir W. G. Armstrong & Co., of Elswick, and at the age of 23 years became associated with his brothers in Manchester. He was one of the original directors of the Manchester Ship Canal Co., and was widely known as a philanthropist.

Oliver Hazard Perry Cornell, a civil engineer and graduate of Cornell University, class of 1874, died at his home in Winston-Salem, N. C., on Oct. 13. He was the son of Ezra Cornell, founder of Cornell University, and a brother of A. B. Cornell a former Governor of New York State, who died in 1904. Mr. Cornell was engaged in engineering work for many years and at the time of his death was Chief Engineer of the Winston-Salem Southbound Ry. He was born in Ithaca, N. Y., in 1842.

Edward Lee Hancock, Professor of Applied Mechanics at the Worcester Polytechnic Institute, died at his home in Worcester, Mass., on Oct. 1, from abdominal sarcoma. He was born on June 28, 1873, at Shullsburg, Wis. His early education was received in the schools of his native town. He attended the University of Wisconsin and graduated with the class of 1898. Three years later he received the degree of M. S. from the same university; during this interval he served as Superintendent of Schools of his birthplace, and for one year as Assistant in Mathematics at his Alma Mater. He then took a position as Instructor at Purdue University, soon becoming Assistant Professor of Applied Mechanics. This position he held with marked success until 1909, when he was called to the Worcester Polytechnic Institute as Professor of Applied Mechanics. As an instructor, Professor Hancock was popular with students and associates, and his loss is keenly felt both by his school and by the many acquaintances who are familiar with his work. He was a member of the American Society for Testing Materials, the International Society for Testing Materials, and of the Society for the Promotion of Engineering Education. Professor Hancock's principal work covers widely known and much-quoted tests of the behavior of ductile metals under combined stresses, the recovery of iron and steel from overstrain, the effect of combined stresses on the elastic properties of materials; investigations of the area of contact of car wheels and rails, of the deformation of locomotive wheels and of the effect of flat spots on car wheels. He was the joint author with Prof. S. E. Slocum of a well-known text-book on the strength of materials. As a writer on these subjects, Professor Hancock's name has frequently appeared in the columns of Engineering News.

Engineering Societies.

COMING MEETINGS.

AMERICAN MINING CONGRESS.
Oct. 24-28. Annual session at Chicago, Ill. Secy., J. F. Callbreath, Denver, Colo.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Nov. 2-4. Annual meeting at Cincinnati, Ohio. Secy., Edward H. Reisner, 20 West 44th St., New York City.

NATIONAL MUNICIPAL LEAGUE.
Nov. 13-16. Annual meeting at Richmond, Va., Secy., Clinton R. Woodruff, 705 North American Bldg., Philadelphia, Pa.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Nov. 14-17. Annual convention at Rochester, N. Y. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN RAILWAY ASSOCIATION.
Nov. 15. Semi-annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York City.

NATIONAL FOUNDERS' ASSOCIATION.
Nov. 15-16. Annual convention at New York City. Secy., F. W. Hutchinson, 915 Hammond Bldg., Detroit, Mich.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting at New York City. Acting Secy., D. H. Cox, 29 West 39th St., New York City.

OHIO SOCIETY OF MECHANICAL AND ELECTRICAL AND STEAM ENGINEERS.
Nov. 17-18. Annual meeting at Canton, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

NEW JERSEY SANITARY ASSOCIATION.
Nov. 24-25. Annual meeting at Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 4. Annual meeting at New York City. Secy., Wm. H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Dec. 4-9. Annual meeting at Havana, Cuba. Sec., Wm. C. Woodward, Washington, D. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual convention at New York City. Secy., Calvin W. Rice, 29 West 39th St., New York City.

NATIONAL IRRIGATION CONGRESS.
Dec. 5-9. Annual session at Chicago, Ill. Secy., Arthur Hooker, 214 Hotel La Salle, Chicago, Ill.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 11-13. Annual meeting at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 12-14. Annual convention at Washington, D. C. Secy., Glenn Brown, the Octagon, Washington, D. C.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 20-22. Annual meeting at Washington, D. C. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

Brooklyn Engineers' Club.

At the regular meeting held Oct. 12, Mr. William J. Grinden presented a paper on "All Metal Construction of Doors and Trim for Fireproof Buildings."

Canadian Society of Civil Engineers.

The first meeting of the fall season was held at Montreal, Oct. 12. Mr. Newman, Chief Engineer of the Universal Transmission Co., gave an illustrated address describing the construction and operation of the Janney universal variable transmission device.

Mining and Metallurgical Society of America.

The society has adopted by letter ballot a resolution providing for the annual award of a gold medal for achievement in the line of mining and metallurgical engineering, as follows:

Resolved, That the Mining and Metallurgical Society of America award annually, under rules to be subsequently formulated by the Council and approved by a majority of the society, a gold medal, valued at $100, to the person who, in the opinion of the society, has done most during the previous year to advance the arts of mining and metallurgical engineering, said medal to be awarded without regard to membership in the society.

National Society for the Promotion of Industrial Education.

The advanced program of papers and committee reports for the fifth annual convention at Cincinnati, Ohio, Nov. 2-4, has been given out as follows: "Cincinnati's Experience in Industrial Education," committee report; "Co-operative Plan of the University of Cincinnati," Prof. Herman Schneider, University of Cincinnati; "Vocational Plans in the High School," Pliny A. Johnston, Principal, Woodward High School; "Part Time School for Apprentices," J. Howard Renshaw, Principal, Continuation School; "The Ohio Mechanics' Institute," John L. Shearer, President, Ohio Mechanics' Institute; "How Shall the Obligation to Provide Industrial Education Be Met?"; "What Types of Continuation Schools Are Most Needed in American Conditions?" Chairman, Carroll G. Pearse, Superintendent of Schools, Milwaukee, Wis.; "Evening Schools," Arthur L. Williston, Principal, Wentworth Institute, Boston, Mass.; "Part Time Schools," Charles McCarthy, former Secretary of the Industrial Education Commission of Wisconsin; discussion and summation by George N. Carman, Director Lewis Institute, Chicago, Ill.; Committee report on National Legislation, David Snedden, Commissioner of Education, Massachusetts; "What Can Be Done for the Factory Worker Through Industrial Education?" chairman, John Golden, General President, United Textile Workers of America; "Industrial Education Necessary to the Economic Development of the United States," chairman, Frederick A. Geier, Vice-President, National Society for the Promotion of Industrial Education, Cincinnati; "Should Trade Schools for Youths Above 16 Years of Age Be Provided at Public Expense?" chairman, James P. Munroe, President National Society for Promotion of Industrial Education, Boston.